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Etiology of Fall-Related Injuries in the Army: Review of Narrative Incident Reports, January to December 2011

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Injury Prevention Program

Etiology of Fall-Related Injuries in the Army: Review of Narrative Incident Reports, January to December 2011

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1 Summary

1.1 Overview

Medical surveillance data has consistently shown slips, trips, and falls to be a leading cause of injuries, both within the Army as well as in the civilian community. This provides a basis to focus and prioritize prevention efforts. However, the circumstances resulting in fall-related injuries can vary substantially. In order to identify effective interventions, additional details about populations, activities, and hazards are necessary.

This effort involved a detailed, systematic approach to consistently interpret Army narrative incident reports attributed to Active Duty fall-related injuries in both non-deployed settings and deployed settings. The calendar year (CY) 2011 was selected as a year for which reporting quality and deployed data was most robust. In context with prior Army studies, the results provide the etiological descriptors of fall-related injuries within the Army including population demographics, most common types of injuries, activities, and risk factors.

The objective of this review was to identify specific activities and hazards for which risk reduction strategies may be applied. This investigation also provides recommendations for key activity cause codes that would facilitate future surveillance, monitoring, and evaluation of these types of injuries.

1.2 Results

A total of 1,242 fall-related injury incidents were identified. These incidents occurred in non-deployed settings that largely included garrison operations (n=988) and deployed settings (n=254) defined by the combat operations of Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn. The overall rates for fall-related injuries are very similar in the non-deployed settings (2.20 fall-related injuries per 1000 person-years) and deployed (2.21 fall-related injuries per 1000 person-years). While younger Soldiers (less than 30 years) and lower ranking enlisted (E1-E4) were found to have statistically higher rates, no demographic group stands out as having an exceptionally high risk of fall-related injury.

Injury types are also similar for both settings. Less than 1% of the fall-related injuries in both non-deployed and deployed settings were fatalities or (acute) permanently disabling injuries (such as amputations). The remaining injuries were identified as temporarily disabling. Of these, the most common type of injuries for both non-deployed and deployed settings were fractures (35% and 33 %, respectively) followed by sprains and strains (30% and 22%, respectively). There were more injuries to lower extremities than any other body region (47% of fall-related injuries in non-deployed settings, 56% in deployed settings), especially for sprains/strains and fractures. Comparison of falls from heights versus falls from surfaces indicated similar rates for sprains/strains and fractures.

In non-deployed settings, key activities associated with fall-related injuries included sports (22%), parachuting (20%), walking or marching (19%), and climbing (15%). In deployed settings, occupational tasks were the primary activity to which fall injuries were attributed (53%). Many of the fall injuries in deployed settings occurred during walking or marching activities, such as patrols

(24%), or when boarding or alighting from a non-moving vehicle (23%). Also, a high number of deployed setting fall-related injuries (17%) were attributed to sports. Snowboarding was identified as the leading sports cause of fall-related injuries in non-deployed settings. Basketball was the next leading sports activity to cause fall-related injuries in non-deployed settings and the leading sports cause in deployed settings. In non-deployed settings, ice and snow were primary hazards for walking and marching falls, as well as many climbing incidents. Boarding and alighting from non-moving vehicles were primary factors in both climbing and occupational task-related fall injuries, especially in the deployed settings. Other notable contributing factors, especially in deployed settings, included inadequate lighting, carrying a load, and fatigue.

This study included falls from non-moving vehicles (e.g., when boarding and alighting). Though the number of non-moving vehicle fall-injuries was limited (n= 53 and n= 51 non-deployed and deployed settings, respectively), the types of vehicles most frequently associated with fall injuries were different for each setting. Additional hazards contributing to the identified fall incidents included carrying military loads, poor visibility and low light, and fatigue. Data were inadequate to estimate impacts of these hazards or determine specific interventions.

Though existing intervention literature for fall-related injuries is limited, effective interventions for both basketball and parachuting ankle injuries were identified as being applicable to several of the injury incidents evaluated in this analysis. For the ice- and snow- related fall injuries, low to moderate cost interventions that center on increased awareness and hazard management were identified, though effectiveness in military settings is not known.

1.3 Conclusions and Recommendations

Fall-related injuries in the Army active duty population of CY2011 occurred at a rate of approximately 2.2 injuries per 1000 person-years in both non-deployed and deployed settings. As in past studies, though fall-injuries were reported more frequently in younger enlisted personnel, no specific demographic groups appear to be at a uniquely higher risk of injury. Also consistent with prior studies, less than 1% of fall-related injuries were fatal. The majority of fall-related injuries are temporarily disabling injuries that result in some lost duty time or restricted work.

Lower extremities are the most commonly injured body region in fall-related incidents. The most common types of injuries, fractures, are serious injuries that can result in an estimated average of120 days of limited or lost duty per fracture injury. Other leading fall-related injuries, sprains and strains, also result in substantial restriction and lost days (an estimated 14 days per injury). In some cases, these temporary injuries may result in long-term or even permanent disabilities that would not be captured in the incident reporting systems used in this analysis. In addition to extensive lost duty time, the medical costs of treatment for these injuries, which represent some of the most common reasons for Army hospitalizations and medical evacuations, are also not reflected by the narrative reports used in this analysis. The seriousness of these types of non-fatal injuries should be given greater emphasis in medical and accident/mishaps documentation.

The fall-related injury rates, basic demographics, and common injury types identified for both non-deployed and deployed settings by this investigation are generally comparable to those of prior studies. However, this analysis suggests unique differences in activities and contributing hazards attributed to the injuries in each setting. This highlights the limitations of grouping “falls” into a single injury-cause category. Gaps and inconsistencies in reporting systems could be improved to facilitate the monitoring of fall-related injuries and priority activities and hazards. For example, nationally-recognized injury cause codes (i.e., International Classification of Disease ICD), are not

routinely documented in military medical records or safety or casualty reporting systems. On the other hand, some data systems capture additional coded variables, but the codes are not well defined or consistently used. For example, some systems already capture whether a fall was "from a height," "from surface," or "from stairs." However, these variables were not consistently applied, and thus were problematic when trying to interpret. As a result, while falls from heights may be presumed to result in more severe injuries, neither the current evaluation nor prior studies have shown this. This may be partially due to the noted gaps in accident reporting, which has historically captured only a small portion of the more severe medically treated injuries. In addition, greater distinction between types of surfaces and heights, including the activity and/or object involved, is necessary to establish interventions and prevention strategies.

Injury reduction interventions must be applied and evaluated in terms of the specific activities and factors to properly assess the benefits and potential effectiveness of interventions. While future inclusion of key activity and/or hazard codes in data systems is needed to fully evaluate the effectiveness of interventions, some interventions associated with some of the activities and hazards identified in this investigation are recommended:

- **Basketball**. Consistent with prior data, basketball was found to be a leading sport associated with fall-related injury in both non-deployed and deployed settings. These were primarily lower extremity injuries such as ankle sprains or fractures. As prior studies have also demonstrated an effective intervention for ankle injuries related to basketball (i.e., ankle braces), requirements regarding the use and/or educational information products regarding the benefits of ankle braces during basketball are recommended.

- **Parachuting.** This evaluation supports other studies that have identified injury types and risk factors associated with military parachuting. Prior studies have also evaluated and confirmed the effectiveness of outside-of-the boot ankle braces to reduce the frequency and severity of ankle-related injuries. As an effective intervention for this hazardous fall-related injury activity, a requirement for use of outside-of-the boot ankle braces during parachuting jumps is recommended.

- **Icy and snowy conditions.** Policy and doctrine on cold weather injuries including Technical Bulletin, Medical (TB MED) 508 should be updated to highlight ice and snow as major contributors to fall-related injuries. Since persons may be at greater risk in areas less prone to ice conditions due to a lack of anticipation of conditions and/or a lack of engineering controls in place, fall risks associated with ice and snow should be emphasized in all locations. Installations should enforce appropriate contracts, equipment, and procedures to remove and control ice and snow in a timely fashion. Though evidence is not currently available to quantify the benefits, multifaceted approaches utilizing low cost interventions such as increased local alerts, signage in areas of icy conditions, and reporting mechanisms for icy hazard areas should be considered by local entities.

- **Non-moving vehicles – boarding and alighting.** In non-deployed settings, fall-related injuries occurred most frequently from light to medium high mobility multi-purpose wheeled vehicles (i.e., HMMWVs) and personally operated vehicles (POVs). In deployed settings, fall-related injuries most frequently occurred from mine resistant armor protected (MRAP) vehicles. A lack of familiarity or training with the MRAP vehicles, along with contributing factors such as load carriage and fatigue, may play a role in deployed boarding and alighting fall-related injuries. Further assessment is recommended to identify whether interventions unique to vehicle types may be beneficial.

- **Walking/Marching and Climbing**. Potential interventions include engineering controls like improved night vision, mechanisms to reduce load carriage impact, balance controls, balance training, and procedures to reduce fatigue. However, current data are not available to estimate any potential benefits or evaluate the effectiveness of such measures.

- **Physical Training and Combat Training**. These activities did not result in a substantial portion of the fall-related injuries identified. No specific hazard factors or interventions are identified, but specific cause codes for these activities are suggested.

2 References

See **Appendix A** for a complete list of reference information.

3 Authority

The APHC Army Public Health Center Injury Prevention Program (IPP) has conducted this assessment in accordance with its mission under U.S. Army Regulation (AR) 40-5, Section 2-19, to help identify causes and risk factors of various musculoskeletal injuries and to identify interventions to reduce these injuries in support of Army-wide force health and readiness requirements [1].

4 Background

4.1 Scope of the Problem with Fall-Related Injuries

This project focused on injuries associated with a cause category referred to as unintentional "Slips, trips, and falls." This is one of the most common causes of injuries in both the U.S. and the Army.

4.1.1 Fall-Related Injuries in the U.S.

Unintentional falls have consistently been reported as the leading cause of nonfatal injuries in the US. They are also one of the leading causes of fatalities. The CDC consistently reports unintentional falls as the overall most common cause of hospital emergency room visits, resulting in approximately 9 million incidents annually [2]. Falls have also ranked as one of the top 3 causes of deaths [3]. In industry, fatal injuries occur primarily in construction, and OSHA cites falls as one of the 2013 "fatal four" leading causes of construction deaths [4]. One non-fatal injury report in industry indicates "falls, slips, and trips" as a primary cause of fractures, and the second leading cause of strains, sprains, and tears [5]. Many studies of working-age adults have recognized that the most serious fall-related injuries (i.e., fatalities and fractures) are attributed to falls from height (as opposed to falls from the same level) [6, 7].

4.1.2 Fall-Related Injuries in the Army

Common musculoskeletal and orthopedic injuries such as strains, sprains, joint derangements, and fractures have been the primary threat to Army medical readiness for at least two decades [**Figure 1;** 8, 9, 10, 11, 12, 13]. Of these injuries, unintentional falls have consistently been identified as a leading cause [13, 14, 15, 16]. Specifically, falls have been leading causes of injury in the Army

and the overall military for outpatient hospital visits (DOD) [13, 14, 15, 16]. Falls have also been identified as a leading cause of injuries among deployed Soldiers and as the second leading reason for non-combat injury air evacuations during these deployments [**Figure 2;** 17, 18, 20, 21].

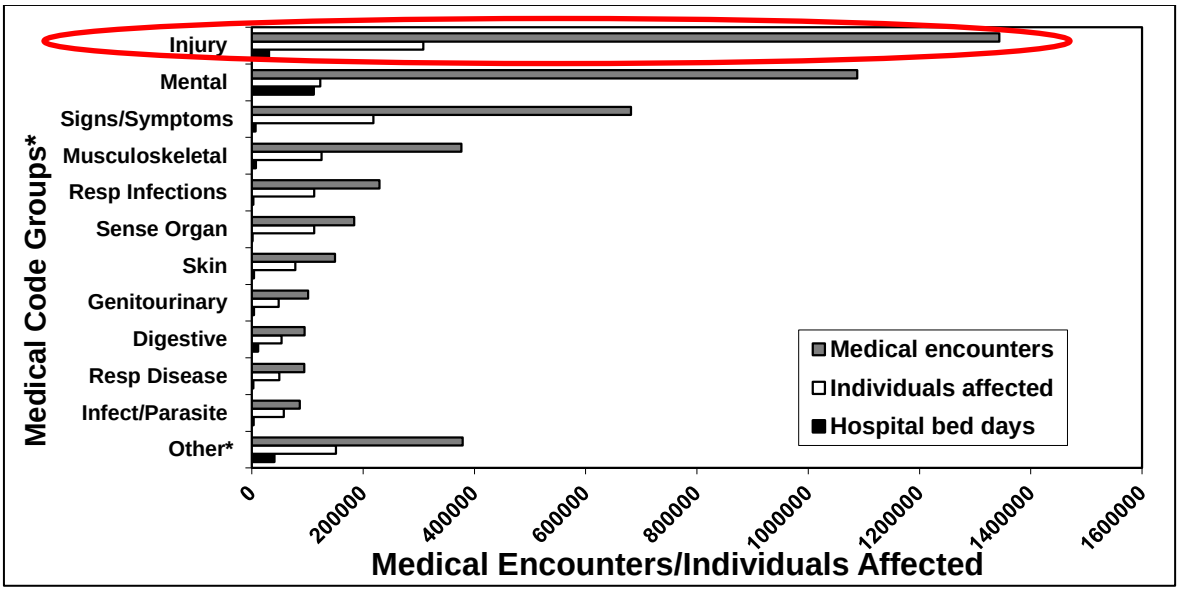

Figure 1. Relative Burden of Injury and Disease, U.S Army Active Duty, 2012

*Based on Internal Classification of Diagnoses version 9 (ICD-CM-9) code groups; "Injury" includes musculoskeletal related injuries; "other" includes all code groups with less than 80,000 medical encounters.

Data source: Defense Medical Surveillance System, 2013; Prepared by Injury Prevention Program, APHC

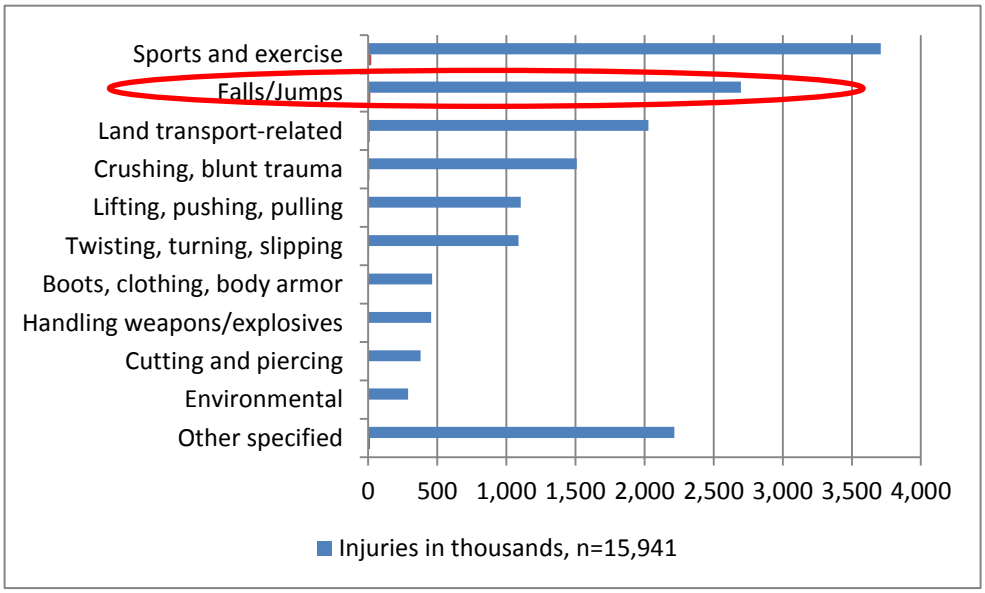

Figure 2. Causes of Air-Evacuated Non-Battle Injuries, 2001 to 2013

*Update (2014) to 2010 analysis of air evacuation data for Central Command area of operation [18]; reflects injuries for which cause was specified (approximately 70%).

Key findings from past evaluations of U.S. Army non-deployed and deployed fall-related injuries are summarized in **Table 1** [17, 18, 19, 26, 42]. Rates from these studies range from 0.13 to 4.7 per 1000 person-years. The range reflects methodological differences including differences in both the definitions of falls (e.g., inclusion or exclusion of slips/trips without a fall, moving vehicle incidents, and sports/parachuting incidents) and the types of data sources (inpatient hospitalization versus accident, versus air evacuation). All previous Army studies have consistently identified fractures as the primary injury type associated with falls (39 to 53%). In addition, all of these prior fall-related injury studies have identified lower extremities as the most commonly injured body region, especially for fractures. Though on-duty activities and boarding and alighting from vehicles have been identified as contributing factors or hazards, types of activities and hazards have been the least consistently defined and least consistently reported aspect of these past fall-related studies.

4.1.3 Definition of Fall-Related Injuries

The generally consistent findings that place falls as a leading injury cause reflect the extremely broad grouping of falls as an injury cause. The circumstances, risk factors, and hazards associated with a fall-related injury can vary quite substantially. For example, a fractured wrist or a sprained ankle could occur when:

- rolling an ankle while running (due to an irregular surface or just misplaced footing)
- rolling an ankle while walking
- going up/down steps
- climbing up/down a ladder
- slipping on ice while jumping out of a vehicle
- tripping over a dog or a box
- playing a game of basketball

While all examples could lead to a fall, it may be more appropriate to describe the circumstances of the fall as the mechanism that results in injury. By this approach, the root “cause” is more appropriately described by the specific activity that lead to the fall (e.g., climbing a ladder, boarding a vehicle, playing basketball), and/or any specific hazard(s) that led to the fall (e.g., ice, hole in sidewalk, fatigue). Databases that collect information on fall-related injuries do not always collect critical details about the activity and/or hazard(s) in a readily extractable and consistent form. Descriptions of locations (home, worksite, healthcare facility), activities (specific job tasks, sport or recreation, personal day-to-day tasks), or hazards (ice, stairs, slippery indoor surface) are either incompletely provided or inconsistently grouped. So while the broad grouping of all “falls” continues to be the leading single cause of injuries, the prioritization of intervention efforts is hindered by a lack of additional details.

Table 1. Comparison of Past Analyses of Army Non-Deployed and Deployed Fall-Related Injuries

Population Scenario	Non-deployed, Hospitalizations n= 28,352 1980 - 1998 Active Duty Army [c]	Non-deployed, Accident reports n=2,311 1994 - 2002 Active Duty Army [b]	Deployed, Air evacuations n= 68,361 2001 - 2012 Iraq/Afghanistan [a]
Data source	Use of hospitalization records and STANAG codes (compared with ICD-CM-9 codes)	Use of detailed Army safety and mishap report data (narratives and ASMIS codes)	Use of air evacuation and casualty narratives with applied STANAG codes
Key conclusions:	-Steady decline in fall injury rates years* -Ladders /stairs least common type of fall -Reliance on ICD-CM-9 would miss many falls	Higher elevation = more severe injury(>hospital/lost work time)	2nd leading cause air evacuation 23% of all non-battle injury
Incident rate	**0.13** - **0.37**per 1000 person-years (# fall injury/1000 Active Soldier*- person years) Hospital coded as falls/same level - at height	**0.59** per 1000 person-years (# fall injury/1000 Active Soldier- person years) based on "falls" variable in Safety data	**3.5 - 4.7** per 1000 person-years (# air evac falls/1000 deployed-person years) Includes jumps and "near falls"
Types of Injuries	**Fracture (41%)** Inter-cranial (15%) Sprains and Strains (12%) [<1% fatalities (usually involve head)]	**Fracture 53%** Sprain/Strain 21.3 %	**Fracture (39%)** Dislocation (19%) [<1% fatalities]
Key Body Regions (non-fatal)	**Lower Extremity (44%)** Head (23%) Upper Extremity (19%)	**Lower extremity (> 38%)** Spine /back torso (>20%) Upper Extremity (>18%)	**Lower extremity (>47%)** Knee (29%), Ankle/foot (18%) Wrist/hand (13%)
Demographics of highest risk groups	**20-26 years old, male**, white, single **Enlisted** *Notes similar to demographics of overall Army*	**20-24 years old,** white, single **Enlisted** Infantry, military police, armor tank crewman	**20-29 years old, male** **Enlisted**
Fall Height	42 % falls on same level 43 % fall from height 15 % falls on stairs or ladders (49%off duty)	49 % falls from same level 51 % fall from elevation	39 % falls on same level 30 % fall one to other level 30 % near falls
Activities	On duty (64%), ~one half in **military training** Off duty (36%) *Potential Hazards identified based on limited review of narratives:* - Climbing in/out of barracks window/balcony - Substance abuse/alcohol - Epilepsy/cognitive/sleep disorder	Most in **military training** (32%) Housing areas (18%) Routine activities (35%) including (walking, **entering/exiting a vehicle**) Sports 12% Physical training 12%	>33% **entering/exiting a vehicle**

Senier 2002 [42][a], Shuping 2009 [26][b], Kersellius 2014 [17][c]

*Decline could be due to a number of policy and procedural changes including: fall injury safety awareness training, engineering controls (anti-slip devices, ice removal), increased reliance on outpatient care, changes in policy for Soldiers in barracks.

4.2 Army Injury Surveillance Data and Fall-Related Injury Coding

While certain data sources used by the Army for injury surveillance provide additional details about the circumstances pertaining to fall-related injuries, there are numerous inconsistencies and data gaps, especially when relying on coded variables (e.g., type of injury, severity, activities or contributing causes or fall height or object type). A primary goal of this project was to apply a consistent coding mechanism across data sources that provide descriptions of fall-related incidents.

4.2.1 Medical Cause Coding

Military injury surveillance efforts often rely on Standard Inpatient Data Records (SIDR), which are the official electronic records of a hospitalization in a Department of Defense (DOD) medical facility. These records code injuries using the universally recognized International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis codes [22]. Injuries include 800-999 code series for acute traumatic injuries and select diagnoses from the 710-739 code series for injury-related musculoskeletal conditions. In addition to diagnostic codes, cause codes are used to help describe circumstances resulting in the injury. There are two primary types of cause coding used by the military:

ICD-9-CM External cause codes ("E-codes")

External cause codes are supplementary to the ICD-9-CM diagnosis and treatment codes and are intended to help capture:

- the intent (intentional, such as suicide or assault, or unintentional/accidental)
- the cause status (e.g., scenario) (E000),
- the activity during which the injury happened (E001-E030)
- the location (place where the event occurred) (E0849.X)
- the factors associated with the mechanism of injury (e.g., Transport vehicles (E880-848) and Accidental falls (E880-899)).

Although the use of E-codes is not enforced, they are sometimes included in medical data records (especially inpatient records). As an internationally recognized system, these codes are used by the civilian sector as well as the military. **Table 2** summarizes potential ICD-9-CM External cause (E) code categories that may be applied to accidental (i.e., unintentional) fall-related incidents. **Appendix B** provides the detailed listing of the individual E-codes in these categories.

Table 2. ICD-9-CM Codes Potentially Applicable to Fall-Related Injuries

Categories	Codes	Description
Status (scenario) codes	E000	Civilian activity or military code (can be used for military task, training, deployment)
Activity codes	E001-E030	Includes sport and recreational activities as well as others such as house maintenance.
Place of occurrence codes	E849.X	Separate codes for barracks versus single homes, work site, recreational or sports facility/area
Vehicle related	E800-848	Boarding/alighting from vehicles (Non-traffic/non-moving)and parachuting are called out with unique codes
Accidental fall	E880- 899	Some codes are detailed and describe types of objects (ladders, scaffolds, furniture) others are more generic (e.g., from surface, from one level to another). Generic "falls" descriptors do not provide information from which risk factors can be determined or interventions can be evaluated
	E949.3	"Delayed effects" due to an accidental falls.
Other causal factors	E908.3	Accident due to natural or environmental factor: Blizzard (snow) (ice)
	E927	Overexertion and strenuous movements: Excessive exercise/ strenuous move

Military Standardization Agreement (STANAG) 2050 Codes

For inpatient hospitalizations, military medical records are required to capture details about the causes of injuries using a separate military coding system as stipulated by the North Atlantic Treaty Organization (NATO) Standardization Agreement (STANAG) 2050: Statistical Classification of Diseases, Injuries and Causes of Death [23, 24, 25]. The STANAG cause codes include an initial trauma code digit to convey whether the intent of injury was battle, non-battle intentional, or non-battle (accident). The last three digits (Injury code) represent the activity or cause of the injury and the location where the injury occurred. As an example, the 12 broad STANAG injury cause code groups are listed in **Table 3**. Fall-related incidents can be included in different STANAG accidental injury categories depending on the circumstances. Primary examples include Air Transport (e.g., injuries related to fall off aircraft, parachuting activities), Land Transport (e.g., injuries related to fall in or around vehicles, including those not in motion), Athletics and Sports (e.g., falling or tripping while running or playing other sports activities), and Falls and Miscellaneous (which includes several codes not associated with falls, including a group sometimes referred to as “near falls” (see **Appendix C** for specific STANAG codes).

Table 3. STANAG Injury Cause Codes (Non-Battle Accidents)

000 - 059	**Air Transport**	**Includes parachuting accidents**
100 - 149	**Land Transport**	**Includes getting in/out of vehicles**
150 - 199	**Water Transport**	
200 - 249	**Athletics & Sports**	**Includes running, physical training, sports**
250 - 299	**Complications-Medical**	
300 - 479	**Instrumentalities of War-Enemy**	
480 - 499	**Instrumentalities of War-Self**	
500 - 599	**Guns, explosives**	
600 - 699	**Machinery, tools**	
700 - 799	**Poisons, fire, hot/corrosive substances**	
800 - 899	**Environmental Factors**	
900 - 999	**Falls, misc. other unspecified**	**Some are falls, near falls, others are not**

4.2.2 Non-Medical Sources: Military Casualty and Army Mishap Data

Existing Army surveillance assessments that provide fall-related injury statistics have relied only in part on medical records. In fact, in deployed situations where medical records have not historically been complete, injury surveillance has relied primarily on databases that capture data on medical air evacuations, casualties, and accidents and mishaps [15, 26]. Specific data sources are described below:

Transportation Command (TRANSCOM) Regulating Command and Control Evacuation System (TRAC2ES). TRAC2ES is a DOD world-wide system used for documentation of all military medical evacuations regardless of mission or location [27]. These data are routinely collected and used to request and coordinate medical air evacuation of Service Members with various injuries and diseases. TRAC2ES contains information from medical records including ICD-9-CM diagnostic codes. It does not provide E-codes for causes of injuries, but often provides a basic description of circumstances that led to the injury. For injury surveillance purposes, STANAG injury codes have been applied retrospectively to the TRAC2ES data by experienced coders reading through patient movement histories. Only evacuations out of the deployed area of operation are captured. When coding incidents that occur during sporting or parachuting activities, slips, trips, and falls, have been primarily cause-coded as Athletics and Sports (200-249) or specific parachuting activities identified in Air Transport (000-059) since these activities are specific STANAG code categories. Likewise, falling while boarding or alighting from vehicles has been coded under applicable Land Transport (100-149) codes (see **Table 2** and **Appendix C**) [28, 29]. In these circumstances, the slip, trip, or fall is captured within a secondary cause code.

Defense Casualty Information Processing System (DCIPS). These data are routinely collected for casualty tracking and mortuary affairs for various deployment operations and include narratives descriptions of incident circumstances. For this evaluation, the number and causes of non-battle injuries (NBI) specific to the Central Command (CENTCOM) area of operation were obtained from DCIPS [30].

Army Safety Management Information System (ASMIS). ASMIS is an Army accident reporting system managed by the U.S Army Combat Readiness Center (ACRC)/Safety Center that is used to report incidents regardless of mission or location. ASMIS is required for reporting accidents in field units from all over the world [31]. Specific criteria are required for reporting thresholds and coding

variables. There are four primary classes of land-based accidents that are to be reported in ASMIS:

- Class A: Accident resulting in property damage of $2,000,000 or more… and/or **an injury or occupational illness resulting in a fatality or permanent total disability**.
- Class B: Accident resulting in property damage greater than $500,000 but less than $2,000,000,…and/or **an injury or occupational illness resulting in permanent partial disability or when 3 or more personnel are hospitalized**
- Class C: Accident resulting in property damage is greater than $50,000 but less than $500,000,…and/or **a non-fatal injury or occupational illness resulting in 1 or more days away from work beyond day or shift which it occurred, or disability at any time (that does not meet definition of Class A or B and is a lost time case).**
- Class D: Accident resulting in property damage greater than $2,000 but less than $50,000,…**and/or a non-fatal injury or illness resulting in restricted work, transfer to another job, medical treatment greater than first aid, needle sticks…, medical removal under medical surveillance requirements, occupational hearing loss, or work related tuberculosis case.**

ASMIS data can be queried to identify specific population or profiles by age, grade, and military occupation specialty (MOS). ASMIS can also be used to broadly identify major problem areas by estimated cost categories, the number of fatalities or severe permanently disabling mishaps, and the frequency of injury occurrence. Because ASMIS Class A and B incidents are especially high visibility they are most likely to be documented. Injuries and illnesses falling into the Class C and Class D categories may not be recognized as accidents or mishaps that require reporting. Among the numerous codes for conditions associated with the incident, ASMIS includes cause codes (e.g., a fall from a height or a fall from a surface). ASMIS reports also include narrative free text (such as activity, narrative, incident description) to allow detailed descriptions of the incident. It is not a medical system, but ASMIS also includes codes for injury types and body region. However, the passive reporting system lacks completeness as well as internal consistency (e.g., between codes and narratives) [14,15, 26].

4.2.3 Comparison of Injury Data from Medical and Non-Medical Sources

Suspected inconsistencies between medical data and accident reporting are well known were quantified in a prior comparison of medical hospital records and accidents reported in ASMIS, which resulted in extremely low match rates [14,15, 26]. In 2004, a DOD expert panel ranked causes of the most common injuries among service personnel for that year. Injury causes for hospitalization records that year highlighted the leading cause as “Falls and miscellaneous” (STANAG 900-999 codes, **Table 2a-b**). The panel conducted a cross match of the individual medical records to the Service’s accident/mishap data for the calendar year 2004. While match rates were low for all Services, they were lowest for the Army [14,15]. As shown in **Table 4**, only 14.5% of Army inpatient injury hospitalization medical records had a matching accident report, while only 0.6% of the outpatient injury records matched to an accident. While these extremely low match rates suggest underreporting of incidents to the Army’s Safety Center, additional factors such as incomplete data and poor data quality were noted. In addition, injuries for which persons delayed seeking medical treatment may not have been recognized or captured as an accident incident. Regardless, the evaluation provided evidence that ASMIS injury rates are substantially lower than that of those being treated. Though admittedly a limited study of a single year of data from 2004, it may be conservatively estimated that ASMIS injury rates represent less than a quarter of injury inpatient hospitalizations and less than 1% of outpatient injury visits.

Table 4. Match Rates of Eligible Safety Cases, 2004 [a]

	Total Eligible Cases	Accident- Medical Match [e]
Accident Report [b]	786	----
Outpatient [c]	60,945	387
Inpatient [c,d]	1,270	184
Inpatient & Outpatient [c, d]	61,154	425 (241=outpatient, 184= inpatient)

[a] Defense Safety and Oversight Council 2006 [14] and Ruscio 2010 [15]
[b] ASMIS.U.S Army Combat Readiness Center 2004 reported accidents
[c] Outpatient and inpatient data from Defense Medical Surveillance System, Army Medical Surveillance Activity
[d] Soldiers who had both inpatient and outpatient matches, defaulted to inpatient
[e] Match if accident report was filed within 90 days of medical visit, or if medical visit was within 7 days prior to accident report

4.3 Relevant Populations and Studies

Basic demographic variables routinely collected in most data systems include **age** and type of **occupation** (among working adults). These two variables tend to be directly related to the causal circumstances of fall-related injuries. A review of the literature shows that past studies have primarily been focused on either elderly populations or specific occupational populations as the subgroups who tend to have highest rates of fall-related injuries. The activities and contributing hazards associated with the fall-related in these populations tend to be quite different. For example, in older non-working populations of persons greater than 65 years of age, falls are often the result of general activities around the home, monitored home living facilities, or health facilities (walking, stairs, getting up or down from furniture). Though external hazards may contribute, these incidents generally reflect internal changes associated with an elderly person's health status (e.g. physiological or mental) [6,33]. In occupational studies, populations are inherently healthy, so fall-related injuries are attributed to unique activities or hazards associated with specific job tasks or the job site [32,33, 34].

Previous studies of fall injuries among specific occupational groups include construction, health care, retailer and restaurant workers, as well as military Soldiers or personnel. These studies provide insight into occupational factors and hazards that lead to fall-related injuries. As an example, falls from heights (such as ladders or scaffolds) are a primary concern in the construction industry [7, 33, 34, 35, 36, 37, 38]. Studies of job sites, like medical facilities and restaurants, have indicated that indoor wet surfaces and stairs are prevalent hazards [39, 40]. The Army has occupational series in which groups such as health care workers, construction and engineering, transportation, and equipment handling operations parallel activities conducted by civilian employee cohorts [41]. It is plausible that findings from civilian occupational studies provide evidence as to the hazards faced by comparable sub-populations of the Active Duty Army population. **Table 5** provides a summary of the primary fall hazards identified by the CDC in healthcare facilities, along with several recommended prevention strategies [40]. These hazards, as well as the associated

prevention tactics, could reasonably apply to military medical treatment facilities and may indirectly apply to other Army activities and facilities as well (e.g., eating establishments, motor pools).

4.4 Prevention of Fall-Related Injuries

Despite its status as a leading cause of injury, only a limited number of peer-reviewed or government studies have provided empirical evidence pertaining to the effectiveness of fall hazard interventions [6, 10, 11].To determine effective interventions, causal and contributing risk factors for fall injuries must be understood. As such, the available intervention study data (e.g., policy change, educational interventions, engineering/physical controls, or combinations of these approaches) is generally applied to only the specific populations studied. However, studies showing significant reductions in occupational fall injury risk could reasonably apply to a comparable military population (for example, health care workers as well as patients in medical treatment facilities) [39]. As shown in **Table 5**, the CDC has embraced a combination of intervention strategies that could reduce fall injuries in all healthcare facilities [40]. Given the variety of factors contributing to fall-related injuries, evidence suggests that a combination of intervention approaches may be most effective in occupational settings [6, 10,11]. The results of this analysis will be weighed against the available evidence for potentially applicable interventions.

Table 5. Leading Hazards Associated with Fall Incidents in Health Care Facilities [40]

Hazard Associated with Fall	Prevention Strategies
Contaminants on the floor (e.g., water, grease, oil)	▪ House cleaning protocols ▪ Use of signs and barriers, visual cues for wet floors ▪ Posted contacts for housecleaning to address spills ▪ Ensure adequate spill cleanup materials at appropriate locations ▪ Provide walk off mats paper towels and umbrella bags, trashcans at entrances, water fountains/sinks, ice ▪ Mats large enough to take several footsteps before floor ▪ Secure mats from moving (tape if needed, mark location) ▪ Employees wear slip-resistant shoes*
Poor drainage (e.g., pipes and drains)	▪ Ensure pipes align with drains ▪ Unclog drains ▪ Redirect downspouts away from sidewalks/pedestrian traffic areas
Indoor walking surface irregularities	▪ Replace/re-stretch loose buckled carpeting ▪ Remove/re-patch blistered broken tiles ▪ Patch/refill cracks >1/4 inch in sidewalks or walkways ▪ Eliminate hazards >1/4" high – use ramps >1/2" , bevel slopes no greater than 1:2 ▪ Create visual cues of changes in elevation (e.g. yellow paint) ▪ Replace smooth flooring in areas exposed to water/grease with rougher surfaces ▪ Make sure elevators align with floors
Outdoor walking surface irregularities	▪ Patch/refill cracks >1/2" in sidewalks, walkways, parking lots ▪ Patch, fill, repave outdoor areas that have deep grooves, holes ▪ Create visual cues (e.g., yellow paint on curbs) ▪ Do not use concrete wheel stops in parking lots ▪ Ensure water system/other structures covered or highlighted
Weather Conditions (e.g. ice and snow)	▪ Maintain aggressive program to promptly remove ice/snow from parking lots, garages, walkways ▪ Distribute winter slip warnings via email, bulletins, other ▪ Place weather warning (freezing conditions) monitors at entrances, lots, garages ▪ Display phone # (poster sign) and encourage personnel to report icy conditions to maintenance department ▪ Place labeled bins of ice melting chemicals near entrances and outdoor stairs - provide scoops, directions, (and Material Safety Data Sheets) ▪ Provide additional mats near entrances ▪ Consider recommendation slip-resistant footwear
Inadequate lighting	▪ Install more light fixtures in dim areas especially around steps ▪ Verify light bulbs work and provide appropriate brightness ▪ Install light fixtures that emit light from all sides
Stairs and handrails	▪ Create visual cues (e.g., yellow paint) on each step edge ▪ Check that stair treads and nosing are slip resistant especially outside ▪ Ensure stairs kept free of ice, snow, water ▪ Ensure adequate lighting ▪ Handrails required for more than 4 steps, but recommend for less than 4 steps. ▪ Ensure handrails adequate height (34"-38") and are continuous ▪ Handrails extend 12 " beyond top step and one tread depth at bottom ▪ Handrails required on both sides of stairs >44" wide, 1 handrail on right side descending for stairs <44" wide
Stepstools and ladders	▪ Train employees on proper use: 3 points of contact with ladder at all times while ascending or descending (2 hands 1 foot, 2 feet and one hand) ▪ Wear appropriate footwear (closed back and sufficient tread) ▪ Place on even surfaces before using ▪ Ensure ladders fully open/locked before climbing
Tripping hazards (e.g. clutter, cords, hoses, wires, tubing)	▪ Clear main walkways ▪ Organize and consider wall mounted hooks, hose spools, shelves ▪ Cover cords with beveled protective cover/tape to floor ▪ Use retractable cords, mount to desks
Improper use of floor mats	▪ Ensure mats/runner sufficient large to allow multiple footsteps ▪ Use beveled edge and non-slip mats, secure from moving ▪ Replace curled, ripped or worn mats (secure with tape if needed) ▪ Use paint/tape markers to note consistent correct positioning

Bell 2008 [39], NIOSH 2010 [40]

*anecdotally is best if employer helps provide/pay for shoes

5 Methods

5.1 Approach

As recommended by previous efforts, this investigation involved a detailed assessment of the incident narratives extracted from safety, medical evacuation, and casualty tracking databases to elicit a more complete picture of documented Army Active Duty personnel fall, slip, and trip injuries. Information contained in the narratives enhanced or modified information drawn from any coded variables included in the original data sources. Due to the detailed nature of the narrative review, data were limited to a single calendar year. While a relatively recent year was desired, to best compare differences between falls in non-deployed and deployed settings, the calendar year 2011 (CY2011) was selected. This was because the deployment injury data after 2011 in the selected sources became notably reduced, presumably a result of the drawdown of forces. The data from the CY2011 non-deployed settings are expected to be representative of current trends in non-combat settings. Definitions of the deployed and non-deployed settings for this analysis are:

Deployed settings. Though military "deployment" status can refer to a variety of operations in locations worldwide (including the continental U.S.), this analysis limited its definition of "deployed settings" to the combat operations defined as Operation Enduring Freedom (OEF), Operation Iraqi Freedom (OIF), and Operation New Dawn (OND). Injury incidents documented as accident, casualty, or medical evacuation (both within and out of the area of operation [AOR]) were included. Injuries occurring during other (non-combat) deployment operations were captured as non-deployed settings.

*Non-deployed settings***.** For this analysis non-deployed settings could occur anywhere in the world and were primarily garrison-based operations, though also included injuries occurring to individuals with deployment assignments other than those to OEF,OIF, or OND.

5.2 Data Acquisition

The CY2011 injury incidents extracted from the ASMIS (accident and mishaps data) and TRAC2ES (medical evacuation data) sources were initially separated into non-deployed and deployed setting data sets and merged by unique identifier and date to avoid duplication of incidents. The DCIPS (casualty) data were merged with the deployed setting data set. Data sets were screened to determine whether injuries were a result of a fall related incident. A pre-coded cause variable "falls" was used from the ASMIS data and a pre-coded cause of injury variable was used from the TRAC2ES data. Those incidents pre-coded as fall were grouped and independently reviewed by both investigators to verify or correct coding based on narratives. A search for "slip", "trip" and "fall" terms in narratives was next used to identify any other potential fall incidents not originally coded in ASMIS or TRAC2ES as a fall. This search term approach was also used for the TRAC2ES and DSCIP data. Next, all fall incidents (those that were previously coded as falls, and those identified by the search term approach) were screened by SSNs to combine any duplicated incidents captured in more than one source. The narrative descriptions for all remaining incidents were read independently by both subject matter experts to determine those that accurately described fall-related incidents. For example, incidents that described an object "falling on a person" were identified as potential fall-related injuries based on the "fall" search term, but were excluded from the analysis. Likewise, "slip of a knife" incidents resulting in a cut were not included, but "slip on ice" incidents were included. Incidents that involved moving vehicles (e.g. falling out of a moving truck or falling off a motorcycle while driving) were not included, but incidents involving stationary vehicles were included (e.g., falling off of a parked military truck).

5.3 Data Analysis

Data for both non-deployed and deployed settings were exported to IBM Statistical Package for the Social Sciences (SPSS® 21) and Microsoft Excel® 2010 for analysis. Demographic information (age, rank, gender) was obtained directly from the source data. New variables were established for coding conditions about the fall incidents (i.e., scenario, injury type, activities and factors) from the original source information.

Table 6 provides the list of categories and subcategories of codes applied to the data. While existing codes provided by the initial source (i.e., TRAC2ES cause codes or injury codes) were used to facilitate re-coding, if the source codes did not correspond to the narrative text the narrative information was given priority to determine a new code. For example, though ASMIS data routinely provide codes for duty status, fall height, and injury severity classification, the location of the incident, the type of object involved, and other factors such as fatigue or ice were not routinely or consistently captured in original codes. “Fall height” and “injury severity” were minimally changed from the original data. Severity was difficult to classify into more detailed levels. Categories included death, permanent disability (based on acute injury, i.e., amputation), restricted or lost duty time, or minor injury with only first aid required. “Injury types” and “body regions” were categorized in a way similar to a Barell matrix [43]. “Scenarios” captured information regarding duty-status, activities, and location (on- or off-post), in a more detailed way than traditional codes. In particular, because modification or intervention could be exerted on military property, facilities or events sponsored by the military, ‘military oversight’ was coded for applicable activities. “Activities” were established based on a review of prior military surveillance and fall-related studies (for example, sports, parachuting, military occupational tasks, walk/marching, and climbing).

As noted in **Table 6**, additional details were captured for certain activities (e.g., specific types of sports, specific types of vehicles). When investigators considered a scenario described as a combination of two activities (e.g., walking while conducting an occupational task, or climbing up on vehicle as part of an occupational task), two activity codes were recorded. In the case of hazard factors, common occupational hazards identified by the CDC (per **Table 5**) were used. Hazard factors were only coded when the narrative description provided information about them. In scenarios described with multiple factors (e.g. ice, carrying a load, fatigue) up to three factors were coded. Quantified results are presented as descriptive statistical frequencies and percentiles**.**

To minimize the subjective nature of the re-coding, all of the data, including narrative free-text incident descriptions, were reviewed separately by two investigators. Investigators each coded separate sets of data and reviewed each other’s codes. Differences were resolved through verbal consensus. Primary narrative fields for ASMIS included “activity description,” “narrative,” and “incident description.” Four “history” fields with free text were reviewed for TRAC2ES, and narratives from DCIPS were captured in two “circumstance” fields.

Fall injury rates for non-deployed and deployed Soldiers were calculated as the number of CY2011 fall injury incidents per 1000 person-years of CY2011 Active Duty person-time for all Army, adjusted for deployment status. Specifically, the CY2011 deployed Active Duty person-time was114,724 person- years [44], so the non-deployed person-time was calculated as 449,132 (the All-Army CY2011 person-time, 563,856 person-years, minus the 114,724 deployed person-years).

Table 6. Code Variables Applied to CY2011 Army Fall-Related Injury Data[a]

Variable Type	Subcategory/ Variable descriptors		
Scenario	Deployed or Non-deployed	On Duty	Assigned duty task (not training) (D) Military training (MT) Parachuting/Airborne ops (PC) Physical training (PT) Sport activity (S) Undirected personal activity
		Non-Duty, on military property	
		Non-Duty, off post, non-deployment only)	Sport activity (N_S) Undirected personal activity (N_P)
Fall Height	From height From surface/same level	Used ASMIS codes with some recodes based in narrative and 2 investigator consensus (e.g., fall from a single step (considered a fall from height in ASMIS) , or fall down a hole)	
Injury Classification	Fatality Permanent disability Temporary lost or restricted duty time Minor injury/first aid	Similar to ASMIS though collapsed categories	

Variable Type	Descriptors	Variable Type	Descriptors
Injury type[b]	Death	**Body Region [b]**	Hand (Wrist/Finger)
	Permanent disability		Arm (Elbow/Shoulder)
	Hospitalization		Foot (Ankle/toe)
	Fracture		Leg (knee/lower/upper)
	Dislocation		Back (spine/ lower/upper)
	Strain/Sprain[c]		Neck
	Tear/torn ligament		Head (Face, nose, jaw)
	Concussion		Chest (clavicle, collarbone)
	Hyperextension		Other
	Laceration/Cut		
	Other		
Activities	Sports[d]	**Hazards/Factors**	Substances on surface [g]
	Parachuting		Poor drainage (Pipes/Drains) [g]
	Physical Training[e]		Indoor surface irregularities [g]
	Walking/Marching		Outdoor surface irregularities [g]
	Climbing (e.g., hill/stair/vehicle)[f]		Weather condition(ice/snow) [g]
	Military Combat Training		Inadequate lighting [g]
	Other Military training		Stairs and handrails [g]
	Military Occupational task		Ladders, stools, scaffolds [g]
	House clean/maintenance		Object/obstacle on surface [g]
	Other		Carrying object
	Unknown		Transport vehicle[h]
			Fainting/dizziness
			Not following safety procedures
			Alcohol use
			Fatigue
			Equipment/equipment failure

[a] Data obtained directly from data sources included demographics (age, gender, rank)
[b] Injury types/body regions were captured as written and grouped after initial extraction; if more than one body part was injured both were captured
[c] includes yet to be diagnosed conditions described as severe muscle or joint pain
[d] Includes the capture of type of sport (i.e., basketball, snowboarding, football)
[e] Includes the capture of type of training (i.e., running, weight lifting, pull ups)
[f] Includes boarding/alighting vehicles, excludes climbing activities associated with military training (i.e., obstacle courses)
[g] These hazard categories reflect the top 10 hazard categories identified by the CDC [40] for health care facilities. Additional hazards identified in military data sources were added.
[h] Includes the capture of type of vehicle. Categories include: Heavy Military multi-purpose vehicles (MPV) Light-Medium military MPV, Tanks and Fighting Vehicles; Mine resistant ambush protected (MRAP) vehicles; Aircraft, Watercraft, privately operated vehicles (POVs), bicycles (not used for sports/training), and other/unspecified.

6 Results

6.1 General

Tables 7a and 7b summarize the resulting numbers of incidents from the different data sources that met the criteria for a fall-related injury. The majority of incidents were solely identified in the ASMIS dataset (73% of non-deployed, 70% of deployed). In the non-deployed settings TRAC2ES provided the additional 27% of incidents (none were duplicated in the ASMIS). Of the initially coded "falls" variable in ASMIS non-deployed settings, the vast majority (>95%) were verified as falls, but 20% of overall fall incidents included in the results were not originally coded as fall incidents in ASMIS. In the deployed settings, there was some overlap between sources; while TRAC2ES did not provide any unique additional incidents, DSCIPS yielded a few (~8 %). The ASMIS deployed setting incidents coded as falls were in line with fall incidents reflected by this investigation.

Table 7a. Non-Deployed Army Fall-Related Injury Incidents, CY2011

Search process step	*ASMIS*	*TRA2CES*	*ASMIS & TRACES*	*TOTAL*
Original incident reports	3937	1254	8	**5199**
Previously coded falls verified to be falls [a]	774	NA	NA	**774**
Identified by "fall" "fell" "slip" "trip" text search (other ASMIS cause codes, not C or D), verified to be falls	188	26	NA	**214**
Total non-deployed fall records identified	**962**	**26**	**NA**	**988**
Not coded as falls and no key words found	*2549*	*1126*	*5*	*3680*
Previously coded falls, not verified to be falls	*22*	*NA*	*1*	*23*
Identified by text word search, but not verified to be falls	*404*	*102*	*2*	*508*

ASMIS: Army Safety Management Information System
TRAC2ES: Transportation Command Regulating Command and Control Evacuation System
NA=Not applicable
[a] *Coded as fall in ASMIS (C or D code)*

Table 7b. Deployed Army Fall-Related Injury Incidents, CY2011

Search process step	*ASMIS only*	*TRA2CES only*	*DCIPS only*	*ASMIS and TRA2CES*	*ASMIS and DCIPS*	*TRA2CES and DCIPS*	*ASMIS, TRA2CES and DCIPS*	*Unclear*[b]	*TOTAL*
Original incident reports	1453	3269	2978	77	26	869	35	208	**8914**
Previously coded falls verified to be falls	178	NA	NA	19	1	NA	11	0	**209**
Injuries identified by "fall" "fell" "slip" "trip" text search, verified to be falls	NA	NA	19	NA	NA	24	2	NA	**45**
Total deployed fall records identified	**178**	**NA**	**19**	**19**	**1**	**24**	**13**	**NA**	**254**
Not coded as falls and no key words found	*1013*	*2380*	*2925*	*30*	*13*	*600*	*13*	*208*	*7182*
Previously coded falls, not verified to be falls	*21*	*NA*	*NA*	*3*	*NA*	*NA*	*NA*	*NA*	*24*
Identified by text word search, but not verified to be falls	*240*	*889*	*34*	*25*	*12*	*245*	*9*	*NA*	*1454*

ASMIS: Army Safety Management Information System
TRAC2ES: Transportation Command Regulating Command and Control Evacuation System
DCIPS: Defense Casualty Information Processing System
NA=Not applicable
[a] *Coded as fall in ASMIS (C or D code)*
[b] *Incident did not have a narrative so source was unclear*

6.2 Injury Rates and Demographics

Overall rates for non-deployed and deployed settings were similar (not statistically different).

Non-deployed personnel:

988 fall injuries/**449,132***CY2011 total non-deployed person-years *1000=
2.20 per 1000 non-deployed person- years.
(= 563,856 total Army CY11 person years minus 114,724 CY2011 deployed person- years)*

Deployed personnel:

254 injuries/**114,724** CY2011 deployed person- years)*1000=
2.21 per 1000 deployed person-years.

Basic demographic characteristics of the deployed and non-deployed populations are presented in **Table 8**. In both deployed and non-deployed settings, fall-related injury incidents were less for officers or those over 30 years of age compared to lower ranking enlisted personnel (E1-E4) and Soldiers under 29 years of age. No gender differences were noted in either setting.

Table 8. Active Duty Army Fall-Related Injury Frequencies and Rates, CY2011[a]

Characteristics	NON-DEPLOYED Fall Incidents N = 988			DEPLOYED Fall Incidents N= 254		
	FREQUENCY (%) CY2011 fall incidents	Compared to % of overall CY2011 Non-Deployed population	**RATE** fall injuries per person-years *1000[b]	**FREQUENCY** (%) CY2011 fall incidents	Compared to % of overall CY2011 Deployed population	**RATE** fall injuries per person-years *1000)[b]
Gender						
Male	85%	86%	2.18	90%	90%	2.22
Female	15%	14%	2.26	10%	10%	2.09
Age						
<20	7%	6%	2.61	4%	2%	3.91
20-24	35%	29%	2.67	31%	30%	2.13
25-29	23%	25%	1.97	30%	26%	2.51
30-34	12%	16%	1.66	8%	16%	1.17
30-39	9%	12%	1.54	9%	11%	1.97
≥40	9%	12%	1.69	7%	15%	1.07
Unknown	6%	--	--	12%	--	--
Rank						
E1-E4	57%	46%	2.75	59%	47%	2.69
E5-E9	30%	37%	1.78	29%	35%	1.86
Officer	10%	18%	1.25	6%	18%	0.86
Other/Unknown	3%	--	--	5%	--	--

[a] 2011 Reported incidents in ASMIS, TRAC2ES, DCIPS

[b] Data for frequencies and rates shown in Appendix D. Statistical significance z-score and p-value for testing two proportions determined using Open Epi online. http://www.openepi.com/PersonTime2/PersonTime2.htm

6.3 Fall-Related Injury Severity, Types, and Body Regions

The fall-related injuries identified in this analysis are presented by body region, severity, and type of injury in **Tables 9a** (non–deployed) and **9b** (deployed) and **Figures 3a** and **3b** (non-deployed and deployed, respectively). Because there was sometimes more than one body part affected by a given injury (e.g., a sprained ankle and a fractured wrist resulting from the same fall), there are more injured body parts listed in these tables than recorded injuries.

6.3.1 Fall-Related Injury Severity

Consistent with prior Army studies (**Table 1**), very few deaths (less than one 1 percent, n=4) resulted from the CY2011 falls identified. No deaths from falls were noted in deployed settings, and the four deaths in non-deployed settings were not associated with any specific activity, although alcohol played a factor in two incidents (where individuals fell from a bridge and a building, respectively). One death involved a parachuting equipment malfunction, and the other was a fall from a roller coaster.

Likewise, few permanent disabilities (less than 1 percent, n=5, all in non-deployed settings and n=1 in deployed settings) were identified this analysis. The activities documented as resulting in these permanent disabilities included recreational rappelling, snowboarding (without a helmet), a fall down stairs, a fall off a ladder, a trip over floor matting, and a fall off of a bunk (after a seizure, related to a history of previous head trauma).

Restricted or lost duty time represented the largest group of the fall-related injury incidents identified (79% of all injuries, n=984; 83%, n=820 in non-deployed, and 65%, n=164 in deployed settings). The types of injuries that resulted in lost or restricted duty time represent substantial variation in injury severity; unfortunately, data were not complete enough to delineate further (e.g., levels of physical activity restriction, number of days lost, number of medical visits or medical costs, extent of disability).

A few reported incidents described a minor injury requiring only first aid; these represented less than 1% of injuries. Therefore, this injury category is not included in Tables 9a and 9b.

6.3.2 Fall-Related Injury Types and Body Regions

Also consistent with prior Army studies (**Table 1**), fractures were the leading overall type of injury for both non-deployed (36%) and deployed (33%) settings. Strains and sprains were the second leading injury type in both settings (32% and 22%, respectively). Both of these injury types are considered restricted duty and lost duty time injuries.

Overall, lower extremities (especially ankle/foot) were the most commonly injured body region in both settings (48% and 56% for non-deployed and deployed settings respectively). However, when combining injury type with body region, lower extremity strains/strains were most common in both settings (21% and 19%), while fractures were almost as frequent in upper extremities (12% non-deployed and 13% deployed, primarily hand and wrist) as the lower body extremities (18% non-deployed and 15% deployed).

Table 9a. Non-Deployed Army Fall-related Injuries: Severity, Types, and Body Regions (CY2011, n = 988)[a, b]

Body Region	Injury Severity &Types											
			Temporary restricted/lost-duty time injuries									
	Death	Permanent Disability	Fracture	Dislocation	Sprain/strain	Tear/torn ligament	Laceration/ cut	Contusion	Concus-sion	Hosp-italized (dx not specified)	Other/ Un-specified	TOTAL
Head & Neck	**1(<1%)**	**2(<1%)**	**12(1%)**	**-**	**14(1%)**	**-**	**33(3%)**	**8(<1%)**	**61(6%)**	**6(<1%)**	**23(2%)**	**160(16%)**
Head & Face	1(<1%)	2(<1%)	7(<1%)	-	5(<1%)	-	32(3%)	7(<1%)	61(6%)	6(<1%)	18(2%)	139(14%)
Neck			5(<1%)	-	9(<1%)	-	1(<1%)	1(<1%)	-	-	5(<1%)	21(2%)
Spine, back, & torso		**1(<1%)**	**50(5%)**	**4(<1%)**	**31(3%)**	**3(<1%)**	**4(<1%)**	**17(2%)**	**-**	**4(<1%)**	**17(2%)**	**131(13%)**
Spine/ Back		1(<1%)	16(2%)	-	31(3%)	3(<1%)	1(<1%)	10(1%)	-	3(<1%)	13(1%)	78(8%)
Torso/chest			34(3%)	4(<1%)	-	-	3(<1%)	7(<1%)	-	1(<1%)	4(<1%)	53(5%)
Upper extremity		**1(<1%)**	**119(12%)**	**16(1%)**	**61(6%)**	**9(<1%)**	**18(2%)**	**15(1%)**	**-**	**1(<1%)**	**36(4%)**	**276(28%)**
Arm/shoulder			33(3%)	13(1%)	36(4%)	7(<1%)	6(1%)	10(1%)	-	1(<1%)	31(3%)	137(14%)
Hand/wrist		1(<1%)	86(9%)	3(<1%)	25(3%)	2(<1%)	12(1%)	5(<1%)	-	-	5(<1%)	139(14%)
Lower Extremity		**1(<1%)**	**171(17%)**	**12(1%)**	**207(21%)**	**25(2%)**	**15(1%)**	**5(<1%)**	**-**	**6(<1%)**	**36(4%)**	**478(48%)**
Knee/leg		1(<1%)	45(5%)	7(<1%)	59(6%)	18(2%)	12(1%)	4(<1%)	-	3(<1%)	24(2%)	173(18%)
Ankle/foot			126(13%)	5(<1%)	148(15%)	7(<1%)	3(<1%)	1(<1%)	-	3(<1%)	12(1%)	305(31%)
Other and Unspecified	**3(<1%)**		**-**	**-**	**3(<1%)**	**-**	**1(<1%)**	**1(<1%)**	**-**	**3(<1%)**	**57(6%)**	**68(7%)**
TOTAL	**4(<1%)**	**5(<1%)**	**352(36%)**	**32(3%)**	**316(32%)**	**37(4%)**	**71(7%)**	**46(5%)**	**61(6%)**	**20(2%)**	**169(17%)**	**1113(112%)**

[a] Some injury incidents described injury as more than one type and or involving more than on body part – so percentages in table add up to >100%

[b] Analysis of CY2011 fall-related injury reports from *Army Safety Management Information System (ASMIS) and Transportation Command Regulating Command and Control Evacuation System (TRAC2ES)*

NOTES:
Dash (-) means zero occurrences. <1 % means more than zero occurrences, but <0.5% of total injuries.

Table 9b. Deployed Army Fall-related Injuries: Severity, Types, and Body Regions (CY2011, n =254) [a, b]

Body Region	Injury Severity &Types											
	Death	Permanent Disability	Temporary restricted/lost- duty time									TOTAL
			Fracture	Dislocation	Sprain/strain	Tear/torn ligament	Laceration/ cut	Contusion	Concussion	Hosp-italized (dx not specified)	Other/ Un-specified	
Head & Neck	**-**	**-**	**3(1%)**	**-**	**1(<1%)**	**-**	**8(3%)**	**-**	**6(2%)**	**4(2%)**	**5(2%)**	**27(11%)**
Head & Face	-	-	3(1%)	-	-	-	7(3%)	-	6(2%)	3(1%)	5(2%)	24(9%)
Neck	-	-	-	-	1(<1%)	-	1(<1%)	-	-	1(<1%)	-	3(1%)
Spine, back, & torso	**-**	**-**	**9(4%)**	**-**	**1(<1%)**	**1(<1%)**	**1(<1%)**	**2(1%)**	**-**	**5(2%)**	**12(5%)**	**31(12%)**
Spine/ Back	-	-	2(1%)	-	1(<1%)	1(<1%)	1(<1%)	2(1%)	-	5(2%)	12(5%)	24(9%)
Torso/chest	-	-	7(3%)	-	-	-	-	-	-	-	-	7(3%)
Upper extremity	**-**	**-**	**34(13%)**	**6(2%)**	**5(2%)**	**-**	**4(2%)**	**2(<1%)**	**-**	**1(<1%)**	**16(6%)**	**68(26%)**
Arm/shoulder	-	-	13(5%)	5(2%)	3(1%)	-	2(1%)	2(<1%)	-	1(<1%)	9(4%)	35(13%)
Hand/wrist	-	-	21(8%)	1(<1%)	2(1%)	-	2(1%)	-	-	-	7(3%)	33(13%)
Lower Extremity	**-**	**1(<1%)**	**38(15%)**	**4(2%)**	**48(19%)**	**5(2%)**	**4(2%)**	**1(<1%)**	**-**	**1(<1%)**	**38(15%)**	**141(56%)**
Knee/leg	-	1(<1%)	13(5%)	3(1%)	8(3%)	4(2%)	3(1%)	1(<1%)	-	-	8(3%)	41(17%)
Ankle/foot	-	-	25(10%)	1(<1%)	40(16%)	2(1%)	1(<1%)	-	-	1(<1%)	30(12%)	100(39%)
Other and Unspecified	**-**	**-**	**-**	**-**	**1(<1%)**	**-**	**-**	**1(<1%)**	**-**	**-**	**15(6%)**	**17(6%)**
TOTAL	**-**	**1(<1%)**	**84(33%)**	**10(4%)**	**56(22%)**	**7(3%)**	**17(7%)**	**6(2%)**	**6(2%)**	**11(4%)**	**86(34%)**	**284(112%)**

[a] Some injury incidents described injury as more than one type and or involving more than on body part – so percentages in table add up to >100%

[b] Analysis of CY2011 fall-related injury reports from *Army Safety Management Information System (ASMIS) and Transportation Command Regulating Command and Control Evacuation System (TRAC2ES), and Defense Casualty Information Processing System (DCIPS) for CENTCOM area of operation*

NOTES:
Dash (-) means zero occurrences. <1 % means more than zero occurrences, but <0.5% of total injuries.

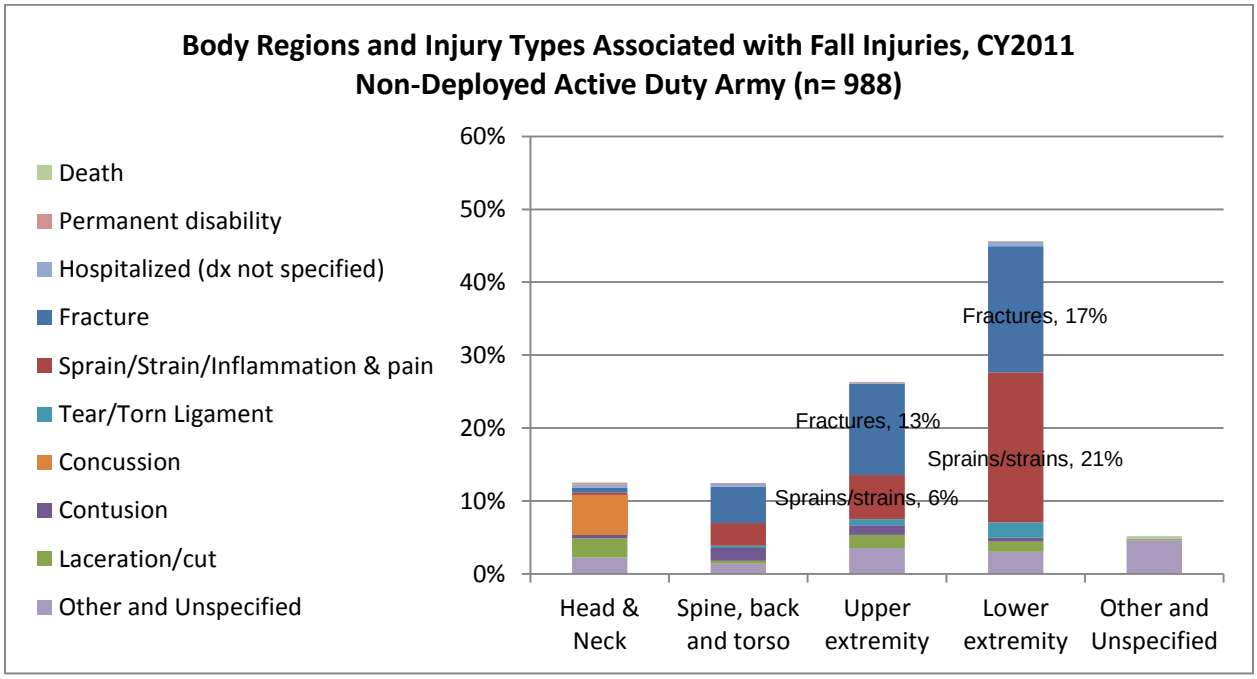

Figure 3a. Non-Deployed Army Fall Injury Type and Body Regions

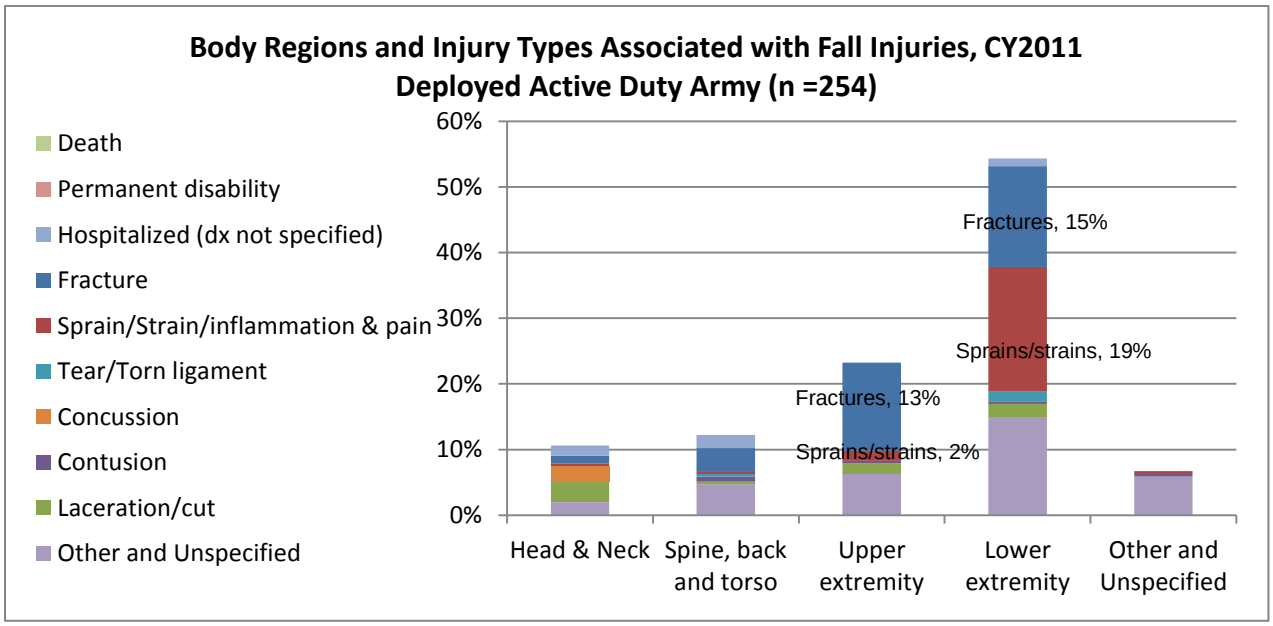

Figure 3b. Deployed Army Fall Injury Type and Body Regions

6.3.4 Injuries Based on Fall Height

As shown in **Table 10**, the deaths and permanent disabilities in this analysis occurred only as a result of falls from heights. Of the most frequent injury types, fractures occurred with approximately equal frequency across fall heights in both non-deployed and deployed settings. More sprains and strains occurred during falls from surfaces.

Table 10. Frequency of Army Fall-Related Injuries Based on Height of Fall

	Non-deployed (n=988)[a]		Deployed (n=254)[a]	
Injury Type	**Falls from height (n=494)**	**Falls from surface (n=491)**	**Falls from height (n=109)**	**Falls from surface (n=145)**
Death	4(1%)	-	-	-
Permanent disability	4(1%)	1(<1%)	-	1(<1%)
Fracture	181(36%)	175(36%)	34(31%)	50(34%)
Sprain/strain	145(29%)	172(35%)	16(15%)	40(28%)
Laceration/cut	25(5%)	46(9%)	5(5%)	12(8%)
Concussion	41(8%)	20(4%)	3(3%)	3(2%)
Contusion	26(5%)	21(4%)	6(6%)	-
Tear/torn ligament	16(3%)	20(4%)	3(3%)	4(3%)
Dislocation	11(2%)	20(4%)	4(4%)	6(4%)
Hospitalized (dx not specified)	13(3%)	7(1%)	6(6%)	5(3%)
Other/unspecified injury type	110(21%)	59(12%)	46(42%)	40(28%)
Total injuries[b]	568(115%)[b]	540(110%)[b]	123(113%)[b]	160(110%)[b]

[a] For three non-deployed incidents, fall height could not be determined from the narrative description.
[b] Because some injuries affected more than one body part, the total affected body parts add up to more than the overall number of injuries in each category.

6.4 Fall-Related Activities and Hazards

A fall is the mechanism by which a person was injured in each incident. The specific activities being conducted prior to the injury must be considered to identify potentially modifiable factors that could ultimately reduce fall-related injury rates. The following sections describe the key activities associated with fall injuries in deployed and non-deployed settings and evaluate specific details regarding the most common hazards and risk factors for individual activities, as well as the severity, body region, and type of injury.

As shown in **Figure 4**, significant percentages of fall-related injuries are associated with sports and parachuting activities in non-deployed settings (sports 22%, n=215; parachuting 20%, n=200) and sports in deployed settings (sports 17%, n=43). Both sports and parachuting have been previously highlighted as leading activities associated with falls [26]. As previously described, these activities are documented under the specific sport or parachuting codes in the Army's inpatient medical cause-coding system (which requires use of STANAG 2050 codes). While the Army's safety and mishap reporting system (i.e., ASMIS) contains variable to identify these activities they were not consistently used in the source dataset.

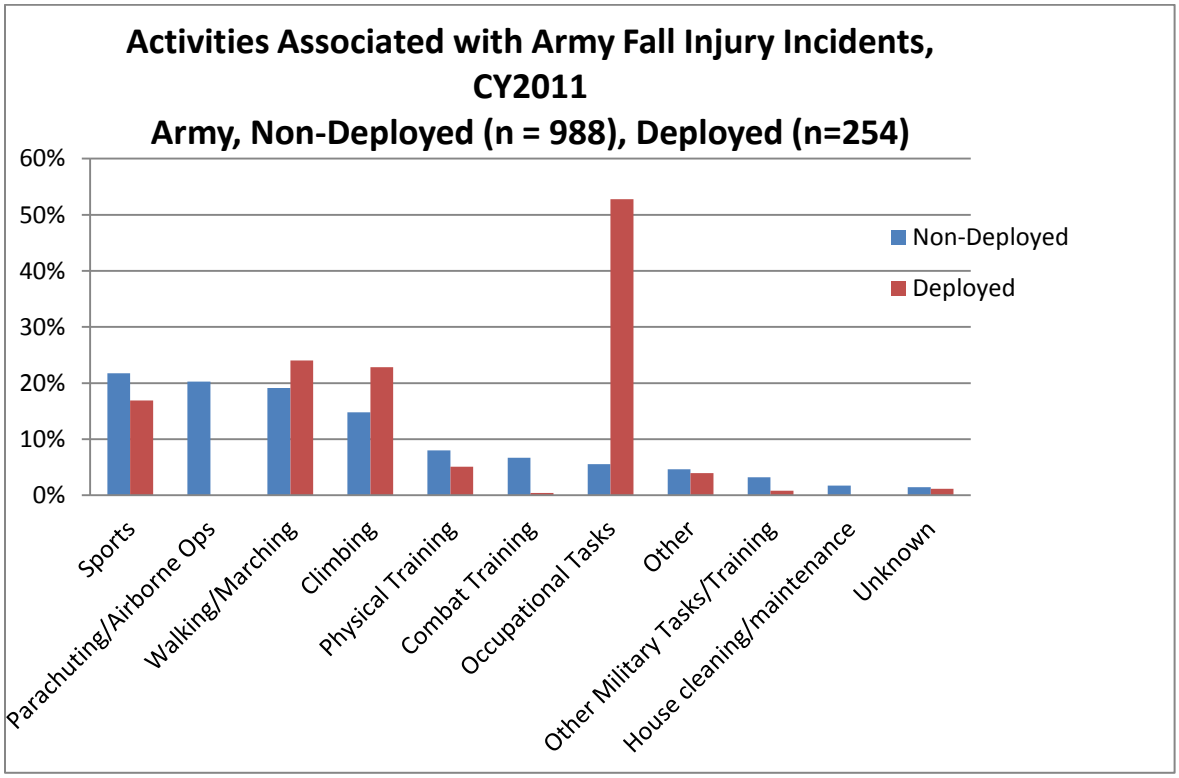

Figure 4. Activities Associated with Army Fall-Related Injury Incidents

6.4.1 Sports

Sports activities are conducted in both non-deployed and deployed settings. In the deployed settings, sports-related activities were considered to be conducted under military control because most sports activities were reported as on-post activities. In non-deployed settings, certain sports activities occurred off military property and without oversight or endorsement of a military entity; these were considered personal time activities**.** **Figure 5a** depicts the types of sports associated with fall-related injuries. **Figure 5b** depicts the hazard factors associated with the sports-related falls. The types of injuries attributed to sports falls are detailed in **Tables 11a** and **11b**. Differences were noted in deployed versus non-deployed incidents:

Non-deployed settings. Slightly over one-half (53%, n=113) of these incidents occurred off-duty during personal time and not on military property. The sports type having the most frequent sports-related fall in non-deployed settings was **snowboarding** (26%, n=55) (Figure 5a). The next most common sport associated with fall-related injuries was **basketball** (20%, n=44), followed by **football (**10%, n=22). Non-deployed sports fall-related injuries were most frequently associated with factors such as obstacles on the ground and surface irregularities (Figure 5b). No specific trends in types of objects/surfaces were noted. The most common injury type resulting from sports-related falls in non-deployed settings were fractures (40%, n=87), followed by strains and sprains

(33%, n=72). The lower extremities were the most frequently injured body region (49%, n=105), followed by the upper extremities (35%, n=76) **(Table 11a**).

Deployed settings. The most frequent sports-related falls in deployed settings occurred during basketball (49%, n=21) (Figure 5a). The sports types having the next most frequent falls were football (23%, n=10) and volleyball (21%, n=9) (Figure 5b). As with non-deployed settings, the injuries were most frequently associated with factors such as obstacles on the ground and surface irregularities. Again, no specific trends in object/surface types were noted. Also similar to non-deployed settings, the most common injury types were fractures (33%, n=14), followed by sprains and strains (30%, n=13). In the deployed settings, lower extremities were the primary body region injured (67%, n=29) and most of these were ankle/foot injuries (53%, n=23) **(Table 11b).**

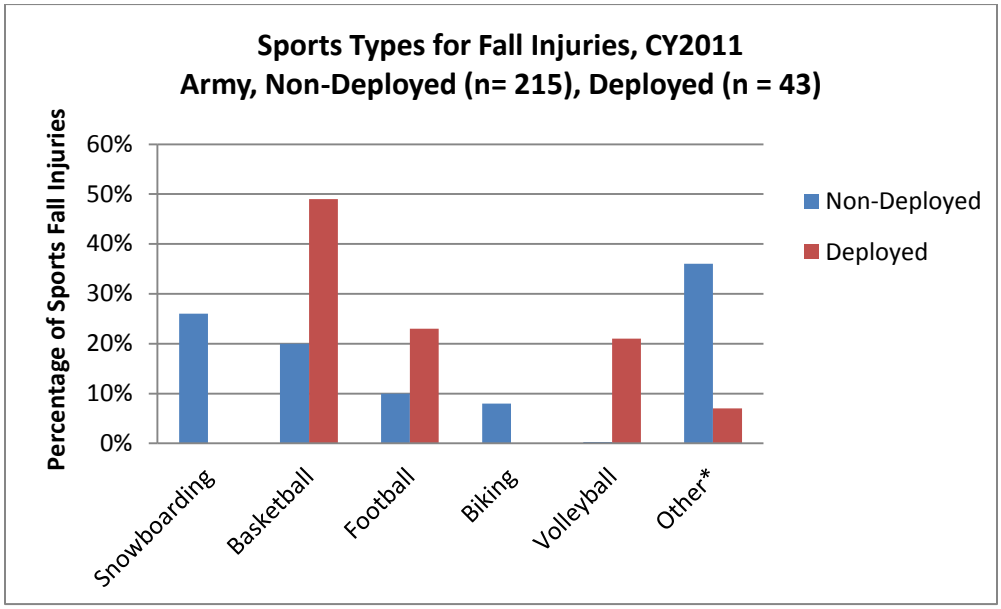

Figure 5a. Sports: Activities Associated with Fall-Related Injuries

* "Other" includes sports with <4% of occurrence (e.g. soccer, Frisbee, softball)

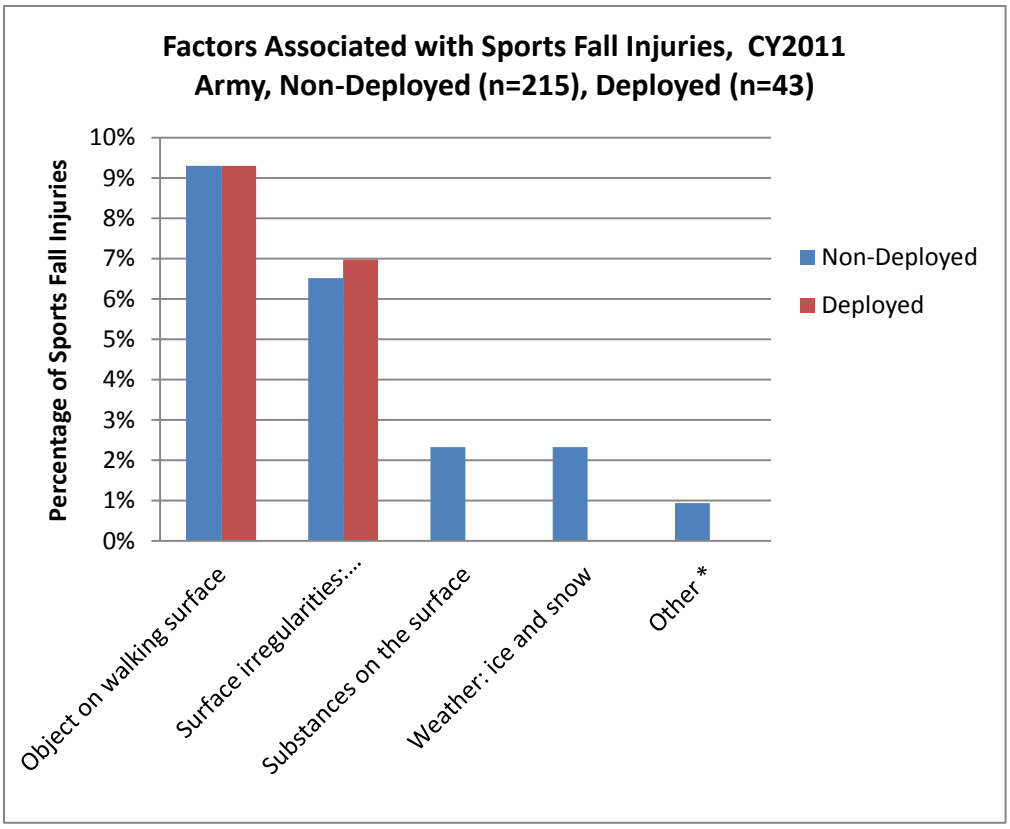

Figure 5b. Sports: Factors Associated with Fall-Related Injuries

* Other includes inadequate lighting (<1%) and lack of situational awareness/failure to adhere to procedure (<1%)

Table 11a. Non-Deployed Army Sports Fall-Related Injuries: Severity, Types, and Body Regions (CY2011, n = 215)[a, b]

Body Region	Injury Severity &Types											
			Temporary restricted/lost- duty time									
	Death	Permanent Disability	Fracture	Dislocation	Sprain/strain	Tear/torn ligament	Laceration/ cut	Contusion	Concussion	Hosp-italized (dx not specified)	Other/ Un-specified	TOTAL
Head & Neck	**-**	**1(<1%)**	**1(<1%)**	**-**	**2(1%)**	**-**	**3(1%)**	**-**	**8(4%)**	**-**	**2(1%)**	**17(8%)**
Head & Face	-	1(<1%)	-	-	1(<1%)	-	3(1%)	-	8(4%)	-	2(1%)	15(7%)
Neck	-	-	1(<1%)	-	1(<1%)	-	-	-	-	-	-	2(1%)
Spine, back, & torso	**-**	**1(<1%)**	**19(9%)**	**-**	**3(1%)**	**-**	**3(1%)**	**4(2%)**	**-**	**1(<1%)**	**-**	**31(14%)**
Spine/ Back	-	1(<1%)	2(1%)	-	3(1%)	-	1(<1%)	1(<1%)	-	-	-	8(4%)
Torso/chest	-	-	17(8%)	-	-	-	2(1%)	3(1%)	-	1(<1%)	-	23(11%)
Upper extremity	**-**	**-**	**37(17%)**	**7(3%)**	**16(7%)**	**3(1%)**	**3(1%)**	**2(1%)**	**-**	**1(<1%)**	**7(3%)**	**76(35%)**
Arm/shoulder	-	-	10(5%)	5(2%)	7(3%)	3(1%)	2(<1%)	1(<1%)	-	1(<1%)	7(3%)	36(17%)
Hand/wrist	-	-	27(13%)	2(<1%)	9(4%)	-	1(<1%)	1(<1%)	-	-	-	40(19%)
Lower Extremity	**-**	**-**	**30(13%)**	**5(2%)**	**51(24%)**	**8(3%)**	**6(2%)**	**-**	**-**	**-**	**5(2%)**	**105(49%)**
Knee/leg	-	-	5(1%)	3(1%)	13(6%)	6(2%)	5(1%)	-	-	-	2(1%)	34(16%)
Ankle/foot	-	-	25(13%)	2(1%)	38(18%)	2(1%)	1(<1%)	-	-	-	3(1%)	71(33%)
Other and Unspecified	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1(<1%)**	**5(2%)**	**6(3%)**
TOTAL	**-**	**2(1%)**	**87(40%)**	**12(5%)**	**72(33%)**	**11(4%)**	**15(5%)**	**6(3%)**	**8(4%)**	**3(1%)**	**19(9%)**	**235(109%)**

[a] Some injury incidents described injury as more than one type and or involving more than on body part – so percentages in table add up to >100%

[b] Analysis of CY2011 fall-related injury reports from *Army Safety Management Information System (ASMIS) and Transportation Command Regulating Command and Control Evacuation System (TRAC2ES)*

NOTES:
Dash (-) means zero occurrences. <1 % means more than zero occurrences, but <0.5% of total injuries.

If ankle braces were used perfectly and could be assumed to eliminate all ankle fractures and sprains associated with playing basketball, this intervention would have eliminated 93% (27/30) of non-deployed foot & ankle injuries from falls during basketball, 28% (21/74) of non-deployed foot & ankle injuries from falls during sports, 13% (28/224) of non-deployed injuries from falls during sports, 9% (27/302) of all non-deployed foot & ankle injuries from falls, and 3% (30/988) of all non-deployed injuries from falls in 2011.

Table 11b. Deployed Army Sports Fall-Related Injuries: Severity, Types, and Body Regions (CY2011, n = 43) [a, b]

Body Region	Injury Severity &Types											
			Temporary restricted/lost- duty time									
	Death	Permanent Disability	Fracture	Dislocation	Sprain/strain	Tear/torn ligament	Laceration/ cut	Contusion	Concussion	Hosp-italized (dx not specified)	Other/ Un-specified	TOTAL
Head & Neck	**-**	**-**	**-**	**-**	**-**	**-**	**1(2%)**	**1(2%)**	**1(2%)**	**-**	**2(5%)**	**5(12%)**
Head & Face	-	-	-	-	-	-	1(2%)	1(2%)	1(2%)	-	1(2%)	4(9%)
Neck	-	-	-	-	-	-	-	-	-	-	1(2%)	1(2%)
Spine, back, & torso	**-**	**-**	**1(2%)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1(2%)**
Spine/ Back	-	-	-	-	-	-	-	-	-	-	-	-
Torso/chest	-	-	1(2%)	-	-	-	-	-	-	-	-	1(2%)
Upper extremity	**-**	**-**	**6 (14%)**	**1(2%)**	**2(5%)**	**-**	**-**	**-**	**-**	**-**	**3(7%)**	**12(28%)**
Arm/shoulder	-	-	1(2%)	1(2%)	1(2%)	-	-	-	-	-	2(5%)	5(12%)
Hand/wrist	-	-	5(12%)	-	1(2%)	-	-	-	-	-	1(2%)	7(16%)
Lower Extremity	**-**	**-**	**7(19%)**	**1(2%)**	**11(26%)**	**2(5%)**	**-**	**-**	**-**	**-**	**8(19%)**	**29(67%)**
Knee/leg	-	-	2(5%)	1(2%)	1(2%)	1(2%)	-	-	-	-	1(2%)	6(14%)
Ankle/foot	-	-	5(14%)	-	10(21%)	1(2%)	-	-	-	-	7(16%)	23(53%)
Other and Unspecified	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
TOTAL	**-**	**-**	**14(33%)**	**2(5%)**	**13(30%)**	**2(5%)**	**1(2%)**	**1(2%)**	**1(2%)**	**0%**	**13(30%)**	**47(109%)**

[a] Some injury incidents described injury as more than one type and or involving more than on body part – so percentages in table add up to >100%

[b] Analysis of CY2011 fall-related injury reports from *Army Safety Management Information System (ASMIS) and Transportation Command Regulating Command and Control Evacuation System (TRAC2ES), and Defense Casualty Information Processing System (DCIPS) for CENTCOM area of operation*

NOTES:
Dash (-) means zero occurrences. <1 % means more than zero occurrences, but <0.5% of total injuries.

If ankle braces were used perfectly and could be assumed to eliminate all foot & ankle fractures and sprains associated with playing basketball, this intervention would have eliminated 71% (10/14) of deployed foot & ankle injuries from falls during basketball, 42% (10/24) of deployed foot & ankle injuries from falls during sports, 23% (10/43) of deployed injuries from falls during sports, 11% (10/91) of all deployed foot & ankle injuries from falls, and 4% (10/254) of all deployed injuries from falls (n=254) in 2011.

6.4.2 Parachuting

For non-deployed settings, most parachuting incidents (99%, n=198) occurred during military training/airborne operations. Only two of the parachuting injuries (1%) were specifically described as recreational parachuting. No parachuting incidents were identified in deployed settings. Many narratives cited "improper parachute landing fall (PLF)" as the cause of injury (**Figure 6**). Injury types attributed to parachuting falls are presented in **Table 12**. The most common injury type was fractures (39%, n=78), followed by strains and sprains (26%, n=51). Lower extremities were the most frequently injured body region (60%, n=119), followed by the head and neck (22%, n=44). Of the parachuting falls, one resulted in death.

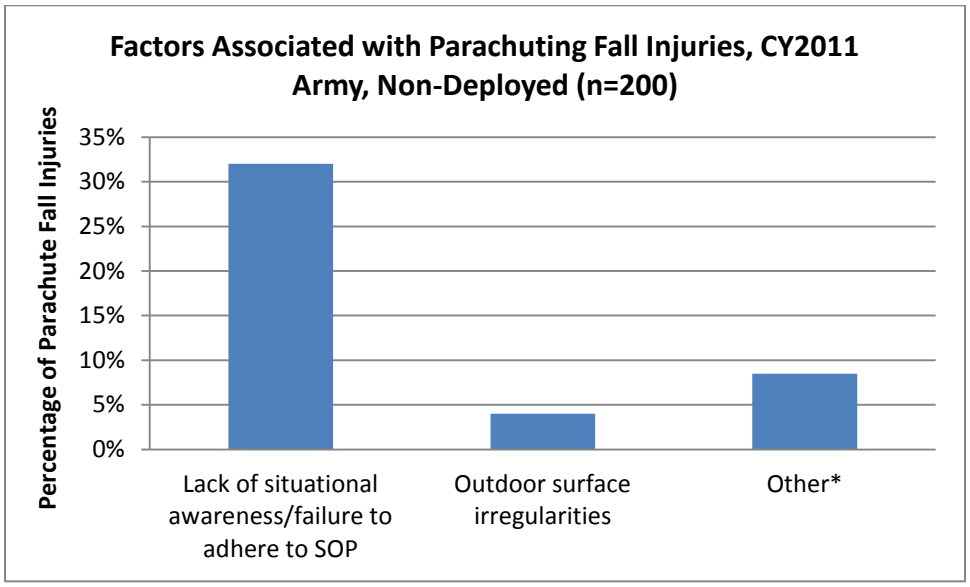

Figure 6. Parachuting: Factors Associated with Fall-Related Injuries

*Other = weather conditions: ice and snow (2%); inadequate lighting (2%); presence of object on walking surface (2%); fatigue (2%); equipment malfunction (1%); alcohol use (1%); transport vehicle - aircraft (1%).

Table 12. Non-Deployed Army Parachuting Fall-Related Injuries: Severity, Types, and Body Regions (CY2011, n = 200)

Body Region	Injury Severity &Types											
			Temporary restricted/lost- duty time									
	Death	Permanent Disability	Fracture	Dislocation	Sprain/strain	Tear/torn ligament	Laceration/ cut	Contusion	Concussion	Hosp-italized (dx not specified)	Other/ Un-specified	TOTAL
Head & Neck	**-**	**-**	**2(1%)**	**-**	**3(2%)**	**-**	**2(1%)**	**-**	**29(15%)**	**3(2%)**	**5(3%)**	**44(22%)**
Head & Face	-	-	2(1%)	-	-	-	2(1%)	-	29(15%)	3(2%)	3(2%)	39(20%)
Neck	-	-	-	-	3(2%)	-	-	-	-	-	2(1%)	5(3%)
Spine, back, & torso	**-**	**-**	**15(8%)**	**-**	**7(4%)**	**3(2%)**	**-**	**3(2%)**	**-**	**1(1%)**	**5(3%)**	**34(17%)**
Spine/ Back	-	-	11(6%)	-	7(4%)	3(2%)	-	3(2%)	-	1(1%)	5(3%)	30(15%)
Torso/chest	-	-	4(2%)	-	-	-	-	-	-	-	-	4(2%)
Upper extremity	**-**	**-**	**4(2%)**	**3(2%)**	**2(1%)**	**-**	**-**	**1(1%)**	**-**	**-**	**5(1%)**	**15(8%)**
Arm/shoulder	-	-	2(1%)	2(1%)	2(1%)	-	-	1(1%)	-	-	5(1%)	12(6%)
Hand/wrist	-	-	2(1%)	1(1%)	-	-	-	-	-	-	-	3(2%)
Lower Extremity	**-**	**-**	**57(29%)**	**2(1%)**	**39(20%)**	**1(1%)**	**-**	**1(1%)**	**-**	**3(2%)**	**16(8%)**	**119(60%)**
Knee/leg	-	-	19(10%)	1(1%)	18(9%)	1(1%)	-	1(1%)	-	1(1%)	9(5%)	50(26%)
Ankle/foot	-	-	38(19%)	1(1%)	21(11%)	-	-	-	-	2(1%)	7(4%)	69(34%)
Other and Unspecified	**1(1%)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**19(10%)**	**20(10%)**
TOTAL	**1(1%)**	**-**	**78(39%)**	**5(3%)**	**51(26%)**	**4(2%)**	**2(1%)**	**5(3%)**	**29(15%)**	**7(4%)**	**50(25%)**	**232(116%)**

[a] Some injury incidents described injury as more than one type and or involving more than on body part – so percentages in table add up to >100%

[b] Analysis of CY2011 fall-related injury reports from *Army Safety Management Information System (ASMIS) and Transportation Command Regulating Command and Control Evacuation System (TRAC2ES),*

NOTES: Dash (-) means zero occurrences. <1 % means more than zero occurrences, but <0.5% of total injuries.

If ankle braces were used perfectly and could be assumed to eliminate all foot & ankle fractures and sprains associated with parachuting, this intervention would have eliminated 88% of parachute foot & ankle injuries (n=67), 20% of all non-deployed foot & ankle injuries from falls (n=302), and 6% of all non-deployed fall injuries (n=988) in 2011.

6.4.3 Walking/Marching.

Figure 7a presents the scenarios under which walking or marching fall-related incidents occurred. These two scenarios included activities conducted during personal time off post, or while under military oversight (meaning an activity conducted under the direction or control of the Army and/or an activity conducted while on or in military property). **Figure 7b** depicts the distribution of factors associated with the marching/walking fall injuries. Substantial differences were noted in non-deployed versus deployed settings:

Non-deployed settings. Non-deployed walking and marching falls associated with activities considered to be under some aspect of military oversight occurred with substantially greater frequency (66%, n=124) than those considered personal activities (34%, n=65). **In non-deployed settings, the leading hazard factor for walking and marching falls was ice and snow** (43%, n=81). The ice and snow slip hazards (primarily described as ice) were not associated with any consistent location. Some narratives explained a lack of situational awareness regarding the hazard (e.g., black or unexpected ice), while a few mentioned that patient had failed to follow local policy requiring the use of anti-slip devices (suggesting there was a known hazard with a locally recommended intervention). In one case, however, a slip was attributed to the anti-slip spike itself as the Soldier attempted to get into a vehicle. The next most frequent hazards were objects on the walking surface (13%, n=25) and outdoor surface irregularities (12%, n=23). Types of objects reportedly tripped over were extremely varied (e.g., dogs, boxes, beds/furniture) and no pattern was discernable. Outdoor surface irregularities included rocks, curbs, and holes in the ground. Substances on surfaces and carrying objects were each noted in less than 10% of the non-deployed incidents. Each was represented by quite varied circumstances, sometimes involving typically slippery surfaces such as bathroom or shower floors or swimming pool decks.

Deployed settings. In deployed settings, the most common factor associated with walking and marching falls was outdoor surface irregularities (48%, n=30). Though much less common, the next most frequent factors included objects on the walking surface (26%, n=16) and inadequate lighting (16%, n=10). These were not mutually exclusive, as 70% of the injuries involving inadequate lighting as an additional contributing factor were also noted as having outdoor surface irregularities and objects on the walking surface factors. Another notable contributing factor was carrying an object (6%, n=4). Unlike in non-deployed settings, the deployed incidents most often referred to military loads being carried. A common fall scenario was represented as a Soldier on patrol, at night with limited lighting, who fell due to a surface irregularity/object (e.g., hill, hole in the ground, rock or branch). Some incidents described an individual carrying a load, while others did not. One narrative indicates that the fall occurred despite the use of night vision eye wear. A few incidents described Soldier fatigue as a contributing factor (captured as "Other").

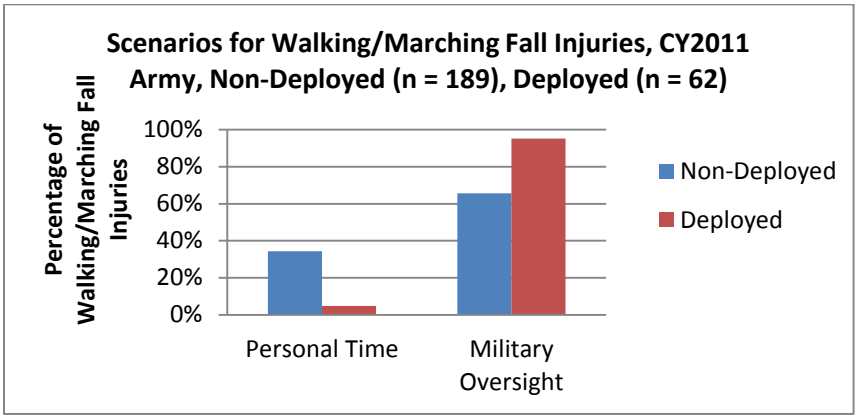

Figure 7a. Walking/Marching: Scenarios for Fall-Related Injuries

* Military Oversight =on duty, as well as off duty if activity supported/endorsed by Army/ on Army property

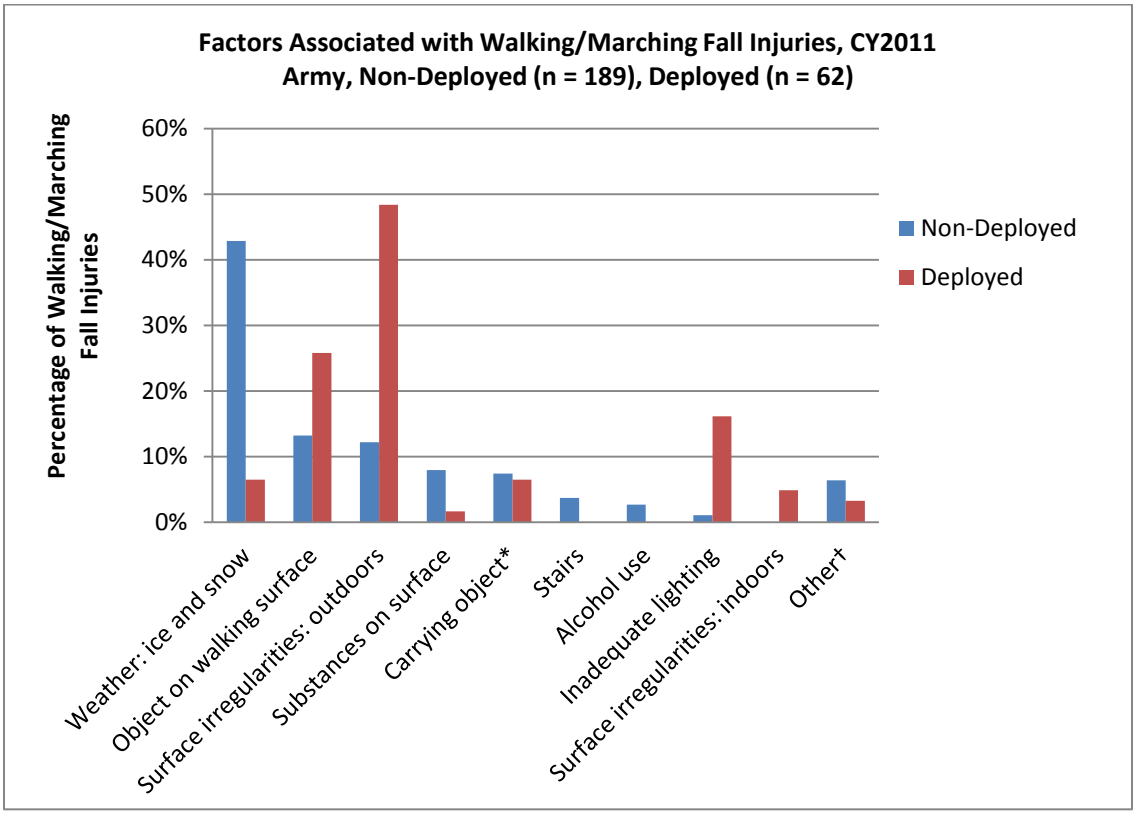

Figure 7b. Walking/Marching: Factors Associated with Fall-Related Injuries

*While some narratives explicitly indicated that a Soldier was carrying an object or a load, other deployed Soldiers represented in the data are expected to have been carrying loads (e.g., for patrols) that were not mentioned.
†"Other" represents factors with ≤2% of Walking/Marching injuries: jumping (not parachuting), transport vehicle, ladders/scaffolds/stools, fatigue, fainting, and lack of situational awareness.

6.4.4 Occupational Tasks

By definition, all occupational task fall injuries occurred during activities under military oversight (control/responsibility). As shown in **Figure 8, non-moving transport** vehicles were the primary factor associated with occupational task falls in both non-deployed (31%, n=17) and deployed (35%, n=47) settings. Because (non-moving) transport vehicles are a common cause of falls during occupational tasks as well as other activities investigated, a detailed evaluation of transport vehicle-related fall injuries was conducted **(Section 6.4.8**). Though vehicles were a key hazard combined with occupational tasks, some occupational task injuries were associated with other hazards and activities, such as walking or marching injuries.

Non-deployed occupational tasks. Following **non-moving transport vehicle**-related incidents, in non-deployed settings, occupational falls were most frequently associated with **ice and snow** weather conditions (16%, n=9). The next most frequently cited activities and hazards included jumping (not parachuting), substances and objects on the surface, and outdoor surface irregularities. Specific details of these incidents were too varied to identify specific objects, substances, and actions.

Deployed occupational tasks. Following **non-moving transport vehicle** related incidents, in deployed settings the occupational falls were most frequently associated with **outdoor surface irregularities** (22%, n=30). Narratives often described terrain features similar to those associated with deployed setting walking and marching fall incidents (e.g., while on patrol). Other key factors included outdoor surface irregularities, objects on walking surface and carrying objects.

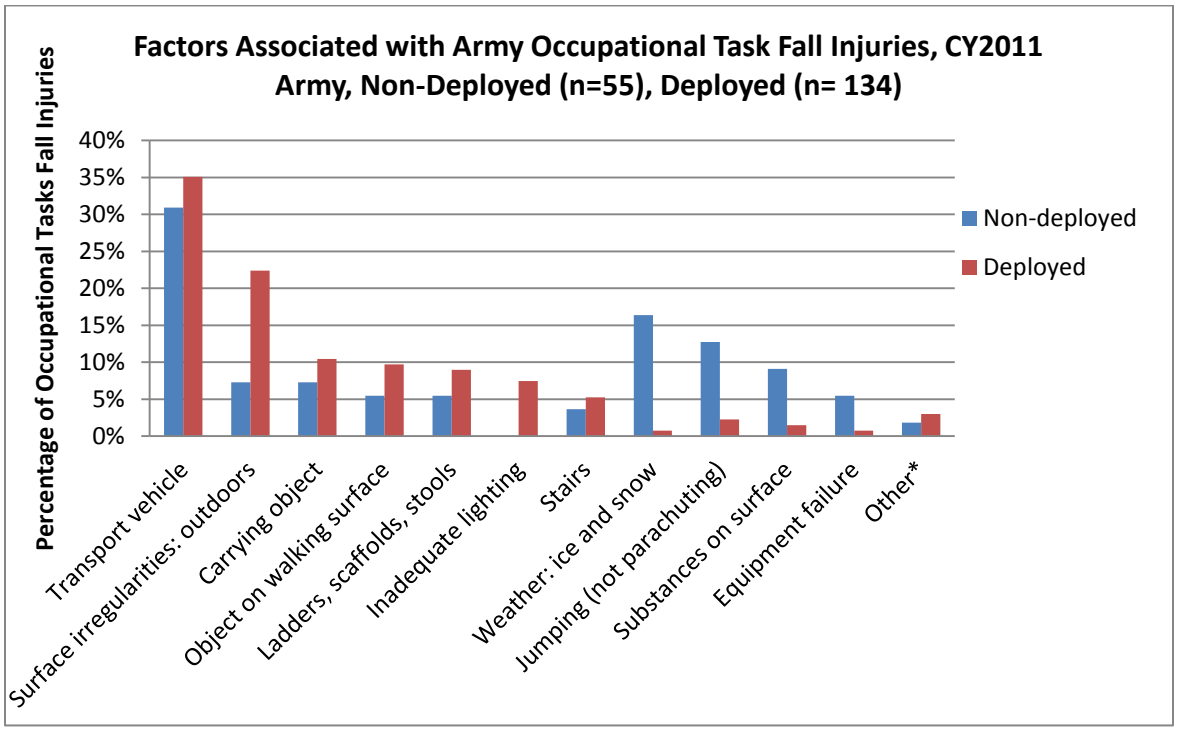

Figure 8. Occupational Tasks: Factors Associated with Fall-Related Injuries

*"Other" represents factors with ≤2% of Occupational Task fall injuries for both deployed and non-deployed: indoor surface irregularities and fainting.

6.4.5 Climbing

Figure 9a presents the scenarios under which climbing-related fall incidents occurred (i.e., during personal time off post versus while under military oversight/control or on military property). As shown in **Figure 9b,** primary factors associated with the climbing-related falls in both non-deployed and deployed settings include: 1) situations involving stairs (53% non-deployed, n= 78; 43% deployed, n= 25) and 2) transport vehicles (24% non-deployed, n= 35; 48% deployed, n= 28). Because non-moving transport vehicles are frequently related to falls during climbing (i.e., boarding and alighting from vehicles) as well as other activities (i.e., occupational tasks), a detailed evaluation of transport vehicle-related fall injuries was conducted **(Section 6.4.8**). Key factors associated with non-deployed and deployed climbing-related fall incidents are discussed below:

*Non-deployed climbing activities***.** Climbing-related fall incidents in non-deployed settings were most commonly associated with **ascending or descending stairs**. Narratives primarily described a lack of situational awareness and/or a combination of other factors such as ice and snow or carrying an object. Though a majority of these incidents occurred on military property/in military facilities, no consistent problem (design, structure, or absence of) associated with engineering controls such as stairs or handrails were noted.

Deployed climbing activities. Climbing-related fall incidents in the deployed settings were most commonly associated with **non-moving transport vehicles**. Types of vehicles associated with fall injuries are discussed in more detail in Section 6.4.8.

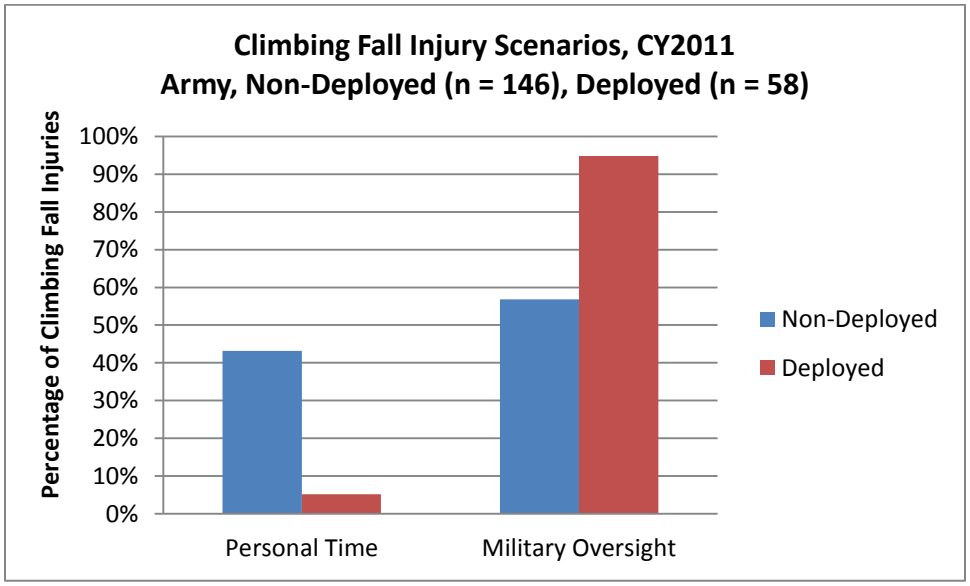

Figure 9a. Climbing: Scenarios Associated with Fall-Related Injuries

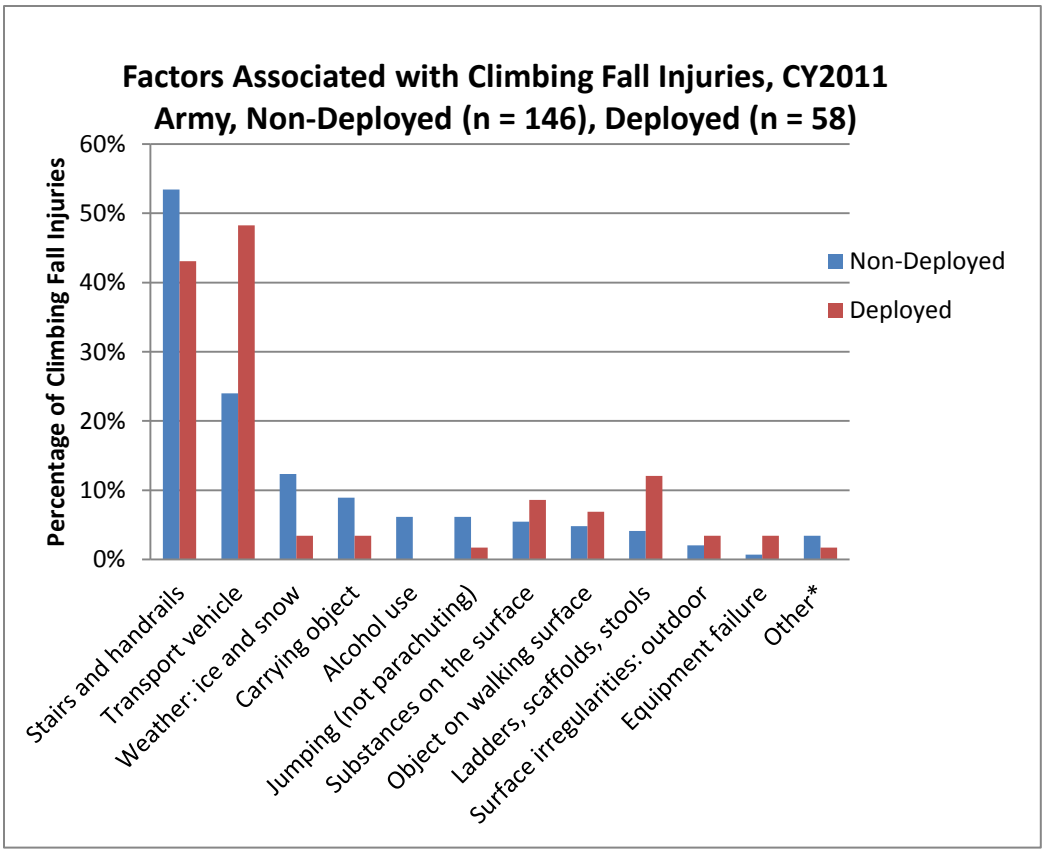

Figure 9b. Climbing: Factors Associated with Fall-Related Injuries

*Other represents Factor categories with ≤2% of Climbing fall injuries for both deployed and non-deployed: inadequate lighting and lack of situational awareness.

6.4.6 Physical Training

Figure 10a presents scenarios under which physical training (PT)-related fall injuries occurred. The the vast majority (95% non-deployed, n=75; 85% deployed, n=11) were under military oversight/control or on military property. Only 18 incidents were captured for deployed settings. As shown in **Figure 10b,** factors primarily associated with PT-related falls (e.g., while running) in deployed and non-deployed settings were **outdoor surface irregularities** and **objects on the surface**, respectively. Though a majority of these incidents occurred on military property/in military facilities, no specific common hazard factor (e.g., deficiency in engineering controls or procedures) was identified.

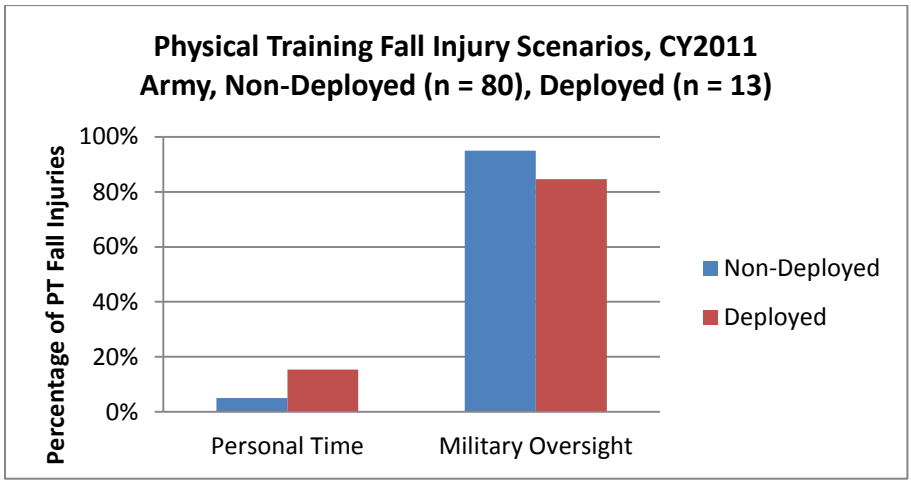

Figure 10a. Physical Training (PT): Scenarios for Fall-Related Injuries

NOTE: Limited population, especially for deployed (n=13)
* Military Oversight = on duty or off duty activity supported/endorsed by military or on military property

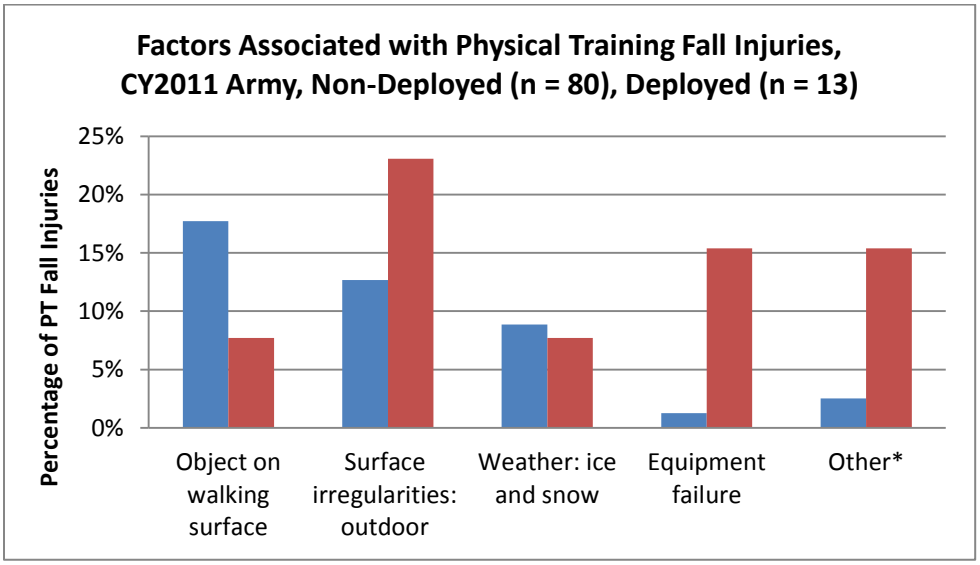

Figure 10b. PT: Factors Associated with Fall Related Injuries

NOTE: Limited population, especially for deployed (n=13);
* "Other" = Factor categories with no more than one instance of Physical Training injuries for both deployed and non-deployed: carrying object, fainting, and inadequate lighting.

6.4.7 Combat Training

By definition, all combat training fall injuries occurred while under military oversight. With the exception of one incident, the incidents (n=66) all occurred in non-deployed settings. As shown in **Figure 11**, thirty-three (50%) of these injuries occurred while navigating an obstacle course. The specific obstacle course activities varied and included wall climbing (e.g., "5-Walls") (18%), monkey bars (15%), and rope climbing (12%). Some of these incidents also involved structures (e.g. ladders and scaffolds) or weather (ice or snow) hazards. The obstacle courses were cited over twice as frequently as combatives training activities. Activities such as drills, swinging, or rope training were possibly a form/part of obstacle courses, but since descriptions were not clear, these are shown separately in **Figure 11**.

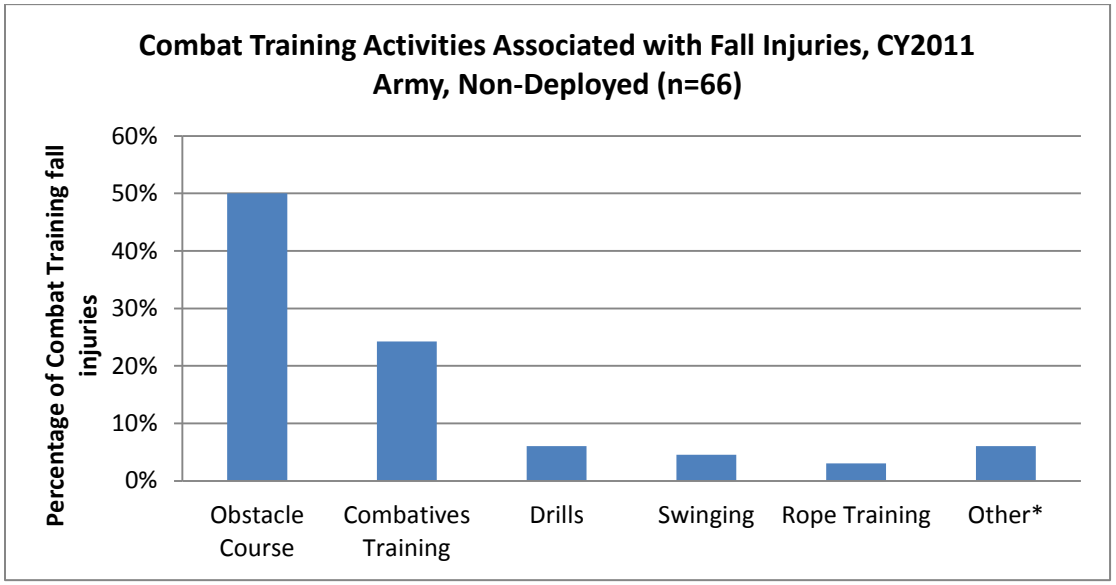

Figure 11. Combat Training: Factors Associated with Fall-Related Injuries

*Other= Combat Training Activities with no more than one instance of Combat Training injuries: Taekwondo, Sparring, Casualty Evacuation, and Unspecified.

6.4.8 Transport Vehicles

As previously noted, non-moving transport vehicles were key factors associated with the falls that occurred during occupational- and climbing- related activities. **Figure 12** presents the types of vehicles associated with the non-moving transport vehicle falls documented in CY2011. Some differences in non-deployed versus deployed settings are noted:

*Non-deployed non-traffic vehicle incidents***.** Military light-medium multipurpose vehicles (MPV) were the most frequently cited type of vehicle (41%, n=21) in the captured non-deployed fall-related injuries involving a non-moving vehicle. Situations typically involved a misstep/slip while boarding or alighting from these vehicles. The next most frequently cited vehicles were privately owned vehicles (POVs) (31%, n=16).

Deployed non-traffic vehicle incidents. Mine resistant ambush protected (MRAP) military vehicles were the most frequently cited type of vehicle (38%, n=20) in the captured deployed fall-related injuries involving a non-moving vehicle. Situations typically involved a misstep/slip while boarding/alighting these vehicles. The next most frequently cited vehicles were military light-medium MPV (26%, n=14), followed by the military heavy MPV (8%, n=4).

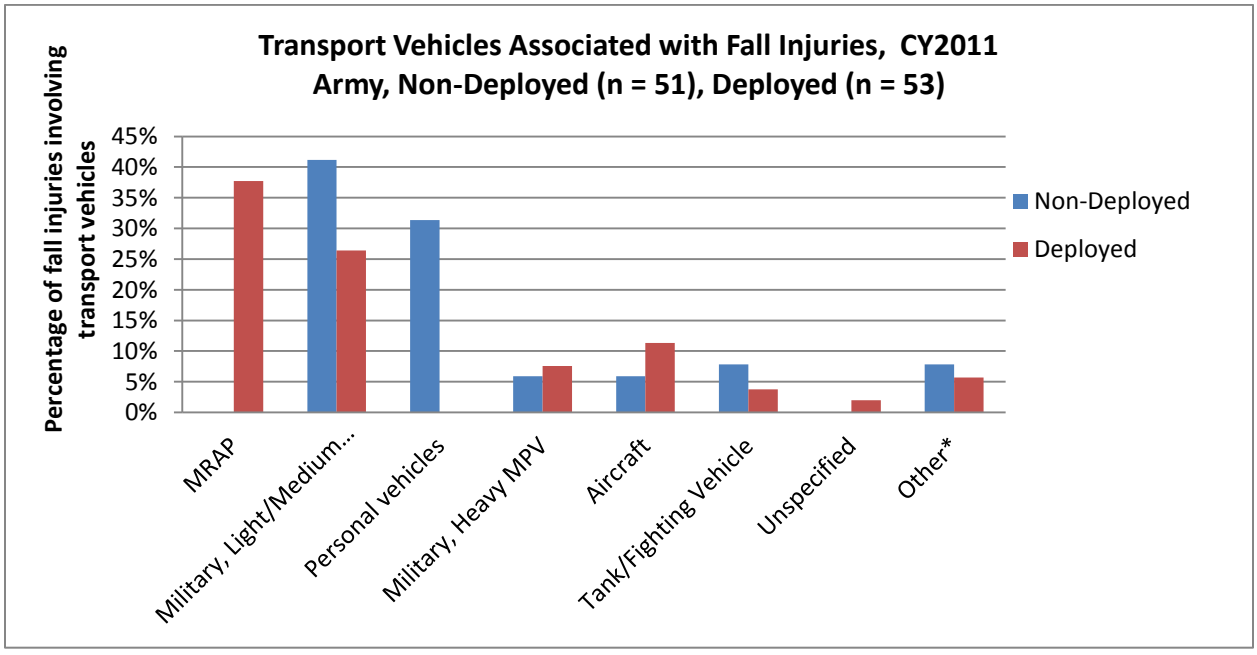

Figure 12. Vehicles Associated with Non-Traffic Fall-Related Injuries

Note. Military, Light/Medium MPV: Includes High Mobility Multipurpose Wheeled Vehicle (HMWWV), Light Armor MV (LAMV), Light tactical MV (LTMV), Military tactical vehicle (MTV) not otherwise specified (NOS), truck (NOS)
Military, Heavy MPV: Includes Heavy Expanded Mobility Tactical Truck (HEMTT), Wrecker, trailer
Tank/Fighting Vehicle: Tank, Stryker
MRAP: Mine Resistant Armor Protected vehicle
Personal vehicles: POV, taxi, RV
Aircraft: Airplane, helicopter
*Other: Includes buses and vehicles with no more than one instance of fall injuries: Palletized Load System, boat, tractor, forklift

7 Discussion

7.1 General

National, occupational, and military injury analyses have consistently identified “falls” or “slips, trips and falls” as a top injury cause. Yet defining falls as an injury cause alone, without clear knowledge of the associated activity and underlying hazard factors, has hindered efforts to identify and evaluate specific interventions regarding this leading injury cause. In Army reporting systems, despite the availability of two forms of medical cause codes (STANAG and ICD-9-CM), details about the circumstances and specific hazards associated with fall-related injuries among active duty Army Soldiers have not been well documented. One possible reason for this is the limited and inconsistent use of cause codes in both the medical databases and the Army mishap or accident safety reporting system (ASMIS).

Prior studies have also found coding gaps and inconsistencies in existing military medical and accident reporting systems. Conclusions of past studies [26,42] have recommended the use of narrative reports as an alternative source for information regarding fall-related risk factors and key activities. The results of this investigation support this notion by identifying details as to the leading activities and hazards associated with Army fall-related injuries in deployed and non-deployed settings. However, a detailed review of narrative reports is a tedious task that is not conducive to routine public health surveillance, monitoring, and intervention evaluation. The findings suggest that defining falls as an injury cause, without additional standardized coding of the activity and hazards, is not an effective or efficient means to obtain actionable information for reducing fall-related injuries.

A limitation of this investigation was the reliance on data systems which include accidents and mishaps, medical evacuation, or casualty reports that are likely to reflect only a small portion of fall-related injuries treated as Army medical encounters. Substantial underreporting in the accident reporting system has been previously documented [14, 15]. Conservative estimates have indicated that safety datasets included less than 15% of inpatient records and less than 1% of outpatient records [14, 15]. The missing data is expected to include numerous musculoskeletal injuries (e.g., sprains, strains) that may not meet accident reporting thresholds, or may have had insidious non-acute onsets. Also, because a determination of permanent disability cannot usually be made when the initial acute injury is treated, this severity category may be underreported. In addition, a portion of the injuries coded as resulting in lost time or restricted duty may have eventually resulted in a chronic condition and permanent disability.

Despite the limitations, many of the broad findings identified during this investigation are consistent with past studies, lending credibility to the trends identified. In addition, as the most serious injuries are most likely to have been captured, the findings highlight injury prevention priorities. It is also noted that reporting compliance may have improved in the decade since the prior assessment.

7.2 Fall-Related Injury Rates and Demographics

Interestingly, despite several different activities and hazards, rates for fall-related injuries in non-deployed settings were almost exactly the same as for the deployed (the non-deployed rate was 2.20 per 1000 person-years, compared to 2.21 per 1000 person-years for deployed). These incident rates are comparable to previously reported fall injury rates (**Table 1**), which range from 0.13 fall injuries per 1000 person-years based on inpatient hospital records to 4.7 per 1000 person-years calculated from deployment surveillance data (which also included injuries resulting from

jumps and near-falls [slips/trips without fall]). Fall-related injuries were more frequent among those under 29 years of age and lower ranking enlisted personnel (E1-E4). No gender differences were noted in either setting. These demographic findings are generally consistent with prior studies (**Table 1**). Even though younger, lower ranking enlisted groups had statistically higher incidence rates, no group stands out as having an exceptionally high risk for these types of injuries.

7.3 Fall-Related Injury Characteristics

The findings of this analysis show the types of injuries and body regions resulting from fall-related injuries among active duty Army Soldiers are similar in both non-deployed and deployed settings. Fractures were the leading type of injury for both settings and strains and sprains the second leading injury type in both settings. While lower extremities injuries were reported most frequently, fractures were essentially as frequent in upper extremities (primarily hand/wrist) as the lower body extremities (primarily ankle/foot). Lower extremity strains/strains were most common in both settings. The findings are generally consistent with those of prior Army studies prior studies (**Table 1** and reference [15]).

Consistent with prior studies (**Table 1**), less than 1 percent of the documented CY2011 fall-related incidents resulted in death (for non-deployed, 4 out of 988; no deaths were reported in deployed setting fall incidents, n=254). Likewise, less than 1 percent of the fall-related injuries were reported as resulting in permanent disabilities. With the exception of alcohol use noted in two of the deaths, no common trends in the circumstances (activities and hazards) were identified.

The severity of the remaining injuries could not be easily defined, beyond noting that they resulted in some amount of lost or restricted duty time. This is not to say that these injuries are not serious. Because these primarily include musculoskeletal injuries which may have later resulted in related chronic or insidious onset conditions, the classification of an injury result as a permanent disability (rather than lost or restricted duty) is likely underreported. Even more often unrecognized is the seriousness of injuries that result in long-term temporary disability.

For example, fractures were identified as the most common type of fall-related injury resulting in restricted or lost duty in both non-deployed and deployed settings. Fractures require substantial expenditures for medical treatment and days of limited duty (DLD). A prior study identified fractures as the military injuries with the greatest outpatient ‘cost’ because they have a high frequency of diagnosis and the highest estimated DLD (120 day for lower extremity fracture and 90 DLD for upper extremity fracture) [15]. The same study [15] indicated that falls were the leading cause of four of the top five injuries resulting in hospitalization, which included lower extremity fractures and upper extremity fractures. The next most frequent injury type for both settings in the current investigation was sprains and strains, most frequently to lower extremity in both settings. The previous study [15] estimated 14 DLD for these types of injuries. Based on this estimate, the leading reported fall-related restricted or lost duty injuries could result in over 40,000 DLDs in one year (**Table 13**). This is likely an underestimation of the total number of DLDs because of the tremendous amount of underreporting expected in the data sources used for this analysis (section 4.2.3).

Table 13. Estimated Days of Limited Duty for the Identified CY2011 Fall-Related Fractures and Sprains/Strains [a]

Setting	CY2011 Fall-related injuries[b,c]	Lower extremity fractures x 120 DLD[a]	Upper extremity fractures x 90 DLD[a]	Lower extremity sprains/strains x 14 DLD[a]	TOTALs
Non-Deployed	1038	171[d] (17%) =20,520 DLD	124[d] (13%) =11,160 DLD	203[d] (21%) =2,842 DLD	**34,522 DLD**
Deployed	281	39[d] (15%) =4,680 DLD	34[d] (13%) =3,060 DLD	55[d] (22%) **=770 DLD**	**8,510 DLD**
TOTALs	1319	**25,200 DLD**	**14,220 DLD**	**3,612 DLD**	**43,032 DLD**

[a] Days of limited duty, as described and calculated in Ruscio et al 2010 [15] applied to injuries identified in this analysis (i.e., results as shown in 9a and 9b)

[b] For some incidents, more than one injury type/body region was documented; therefore the total number of injuries exceed the total number of incidents (non-deployed n = 988, deployed n = 254). For additional details see Tables 9a and 9b.

[c] Dislocations, torn ligaments, lacerations, concussions, and contusions each represented infrequent injuries in both non-deployed and deployed settings. It is expected that some of these injuries (e.g., dislocations, torn ligaments) may have been misclassified as sprains/strains or minor injuries, or not documented due to a lack of an initial medical diagnosis, insidious onset of symptoms, or unmet reporting thresholds. For some fall injury incidents injuries no information regarding the type of injury or the body region was noted (34% deployed, 13% non-deployed).

[d] Of the non-deployed lower extremity fractures, 56 (33%) were due to a parachuting training incident. Sports activities were the next most commonly reported activity associated with non-deployed fall-related fractures, accounting for 37 (25%) of the upper extremity fractures and 29 (17%) of lower extremity fractures. Of the 203 lower extremity sprains and strains during non-deployed falls, 25% occurred during sports activities and 20% occurred during parachuting training. In deployed settings, 20% of lower extremity fractures, 20% of lower extremity strains/sprains, and 15% upper extremity fractures were due to sports activities.

7.4 Fall-Related Activities and Factors

Though the injury types and affected body regions resulting from non-deployed and deployed fall-related incidents are similar, this analysis demonstrates some differences in the underlying activities and hazard factors prevalent in each setting. This is not surprising, given the variability of environmental and occupational exposures that Activity Duty personnel have in these different settings.

The leading activities associated with the non-deployed fall injuries included parachuting (airborne operations) training and sports, followed by a mix of human movement activities, including walking/marching and climbing. In non-deployed the most frequently reported types of fall-related injuries (fractures and sprain/strains) were primarily due to parachuting training. This finding has supports previous findings that identify parachuting training as a leading activity resulting in injuries to the lower extremities, especially ankle and foot injuries [15]. Sports activities were the next most commonly reported activity associated with fall-related upper extremity fractures, lower extremity fractures, and lower extremity sprains and strains. This also supports previous findings [15].

For the deployed settings, the leading activity was identified as occupational tasks, followed by walking/marching and climbing. This is not surprising, as time during a deployment is primarily spent conducting military tasks. For leading injuries types however, 20% of lower extremity fractures, 20% of lower extremity strains/sprains, 15% upper extremity fractures were due to sports

activities. With all activities, some differences in underlying details, circumstances and hazard factors were found to depend on the non-deployed or deployed settings.

The cause status code may be an alternative to the use of “on duty” or “off duty” codes. The ICD-9-CM* E-codes for “Cause Status (scenario)” and “Place of Occurrence” may be beneficial to differentiate between activities occurring at an off post residence/location or at a facility/location on post:

E000.1 = civilian
E000.2 = military

E849.0= Home
E849.3= Industrial place/premises (e.g. warehouse, (motor pool)
E849.4= Place for recreation/sport
E849.7= Residential institution (e.g. barracks, hospital)
E849.8= Other specified place (forest, hill, beach) [suggest for other outdoor locations]

*** NOTE:**

Beginning in October 2015 the DOD is required to replace ICD-9-CM codes with ICD-10-CM codes. A crosswalk of the ICD-9-CM codes recommended in this report has been added as Appendix E.

7.4.1 Sports

Sports are one of the most frequently reported activities associated with fall-related injuries in both non-deployed and deployed settings (associated with 25% and 16% of fall injuries, respectively). This is consistent with prior findings [15, 26], including deployment surveillance findings that indicate that sports-related injuries are one of the leading causes of medical air evacuations from Iraq and Afghanistan [17,18].

Snowboarding was the most common sport (26%) associated with non-deployed fall-related injuries (26%). Basketball (20%) and American football (10%) were the next most commonly cited sports activities associated with non-deployed fall-related injuries. Snowboarding was not a typical option for those deployed, so fall-related sports injuries in deployed settings were most frequently due to basketball (49%) and football (23%), followed by volleyball (21%).

The types of sports injuries captured in both non-deployed and deployed settings were most frequently fractures, followed by sprains and strains. Lower extremities (i.e., ankle, foot, or knee) were the most frequently injured body areas. Not surprisingly, basketball was a leading activity associated with these lower extremity injuries. Lower extremity injury types (especially ankle injuries) have repeatedly been identified in other studies as the most common basketball injury [45, 46, 47]. Consistent with this investigation's definition of a “fall,” a prior study of U.S Air Force safety reports specifically identified the leading cause of basketball injuries as a fall when “jumping/landing awkwardly,” as opposed to landing on someone’s foot, collisions with other players, pivoting, or being pushed [45].

The fall-related injuries due to sports activities identified in this analysis do not represent all of the injuries that were associated with these sports in CY2011. Given the specificity of the sport as an

underlying cause of these injuries, coding of sports injuries may be alternatively classified by an ICD code that represents “sports” or the specific sport in question.

ICD-9-CM E- Activity codes “E007.X” (**Table 2)** that are recommended include:

E007.6 = Basketball
E007.0 = American tackle football (* NOTE: may not be appropriate for Flag Football)
E007.7 = Volleyball
E007.9 = Other (team sport)

7.4.2 Parachuting

Parachuting/airborne operations were one of the leading non-deployed activities associated with fall-related injuries, causing 20% of these injuries. The parachuting fall injuries identified do not represent all injuries that were associated with parachuting activities, only those associated with a fall (usually the landing fall), but the results show similarities to the types of injuries commonly identified in prior studies of military parachuting operations. Injuries and risk factors associated with military parachuting have been well studied [48, 49, 50, 51, 52]. Many of the incident descriptions evaluated during this investigation indicate that the injuries were associated with improper "parachute landing fall (PLF)." In most of these cases, there were insufficient details to determine potentially contributing hazard factors. So while this analysis does show, consistent with prior parachute studies, that ankle fractures and sprains are predominant injury types associated with parachuting, the narrative descriptions were not found to be particularly useful for collecting additional details to identify risk factors or possible interventions.

A prior study of military parachuting injuries and risks has provided documentation of several risk factors including night jumps (versus day), combat loads (versus unloaded jumps), high wind speeds, high humidity, specific aircraft (C17Globemaster or C130 Hercules), and exits through the side doors versus tailgates [48]. Several studies have also evaluated the potential benefits of using external parachute ankle braces (PAB) as an intervention to reduce these injuries, and consistently concluded this to be an effective intervention [49, 50, 51, 52]. The PAB is not mandated due to anecdotal reports about its potential to increase risk of other injury types as well as the costs of replacements. However, more recent studies have determined that injury risks do not increase when PABs are in use [49], and that “the use of PABs reduces ankle injuries by about half and is a cost effective device that should be worn during military airborne” operations to reduce injury risk [50].

As with sports, the injuries associated with parachuting identified in this analysis do not represent all parachuting injury incidents experienced by the Active Duty Army. Assigning these injuries as a fall is not consistent with STANAG coding guidance, and given the body of literature focused on addressing specific parachuting injuries and risks, it is reasonable to use cause criteria specific to parachuting.

Therefore, the existing ICD-9-CM E-code(**Table 2, B-2)** that is suggested for documenting injuries related to this activity is the specific Transport vehicle (Air and Space) ICD-9-CM E code E843.X:

E843.7= Parachutist military/other

7.4.3 Walking/Marching

Walking or marching was another leading cause of fall-related injuries in both non-deployed and deployed settings (representing 19% and 25% of fall injuries, respectively).

In non-deployed settings, the most common fall hazard associated with walking and marching injuries was ice and snow. This analysis supports national guidelines that recognize ice and snow to be major contributors to fall-related injuries ([40], **Table 5**). It cannot be determined specifically from this investigation whether these conditions are greater in locations that experience ice and snow more frequently. Because numerous incidents reported a lack of situational awareness about icy conditions, it is possible that risks are higher in locations that experience these conditions less often, where people may be less prepared. Though ice and snow are nationally recognized fall hazards, fall-related injuries are not identified as a common cold weather injury in Army cold weather injury policy or doctrine [53]. Existing doctrine identifies injuries such as frostbite and hypothermia, as well as cold-related illness such as carbon-monoxide poisoning and snow blindness. Injuries such as sprains, strains, and fractures from falls on ice or snow would be reasonable additions to include in both the cold weather doctrine and the associated annual required awareness training.

One intervention that has been studied in various healthy adult/occupational settings to address this hazard has been suggested is the use of anti-slip footwear (such as show spikes or cravats) [54, 39] for certain outdoor occupations [40]. Army installation Commanders are authorized to institute local policies to wear such devices. Narrative descriptions of incidents reported in these analyses provide some indication of local policies. While attempts to determine the existence and content of such policies, their enforcement, and tracking for effectiveness were made, no such data was found to be readily available. Some evidence does support the effectiveness of certain devices to reduce fall injuries under certain conditions, but the literature on this intervention is limited [54, 39]. Effectiveness is dependent on many factors, including the type of population/occupation, activities conducted, time outdoors, types of anti-slip devices, and motivations and/or enforcement methods to ensure proper use. Based on the varied circumstances identified in this analysis, many of the criteria needed to be met to ensure the effectiveness of anti-slip wear effectiveness are not feasible and/ or would not likely have prevented the fall injuries reported. As such, endorsement of anti-slip wear for use by Active Duty personnel cannot be made at this time.

Several administrative and snow and ice removal interventions for reducing ice and snow hazards are highlighted by national guidelines [40]. These may be used to varying degrees at most Army installations. While the extent and magnitude to which they may reduce fall injuries on military properties is not fully evidenced by available intervention effectiveness studies, even limited reductions in injuries may warrant their implementation when cost is minimal, implementation/execution is feasible and practical, and other risks (especially health risks) are not incurred. It is suggested that Army installations evaluate the use of minimal to moderate cost interventions reflected by national guidelines such as those listed in **Table 14** (others are described in **Table 5** or [40]).

Table 14. Example Interventions to Reduce Ice and Snow Fall Injuries

Awareness/education	Modify Army cold weather doctrine (TB Med 508) and policy to include fall-related injuries (e.g., fractures and strains/sprains) as a cold-weather related injury	*Costs*	Minimal to none (Administrative)
		Precedent	Regional and local military installations/other government and non-government organizations
		Benefits	Increased awareness
		Disadvantages	No quantified injury reduction can be estimated from current data
	Provide warnings, alerts, and signage for pending ice or snow conditions and the associated fall hazards with special emphasis on areas known for black ice	*Costs*	Minimal to none (use of existing installation alerts emails, broadcasts, to purchase of sign systems)
		Precedent	Regional/ local military installations/ other government/non-government organizations
		Benefits	Increased awareness
		Disadvantages	No quantified reduction/effectiveness can be estimated from current data. Requires a responsible party, mechanism, and information sources.
	Establish reporting system (phone/email) for reporting hazardous areas on post areas (with response resources to address hazard reduction needs)	*Costs*	Moderate to none (use of existing installation alerts emails, broadcasts)
		Precedent	Regional and local military installations/other government and non-government organizations
		Benefits	Increased awareness
		Disadvantages	No quantified reduction/effectiveness can be estimated from current data. Requires a responsible party, mechanism, and resources to respond
Engineering controls	Ensure timely snow removal /application of ice melting agents (salt/similar compounds)	*Costs*	Moderate (materials, personnel)
		Precedent	Standard procedure at most locations (military installations/other government and non-government organizations)
		Benefits	Removal of hazard will reduce risk
		Disadvantages	Typically is already conducted – may need improvement in locations/areas for which a responsible party, mechanism, or resources are needed to respond; also must factor in problems with refreezing
	Provide ice melting agents (salt/similar compounds) or anti-slip materials (sand) for individual facility/unit use and ensure proper absorbent /ant-slip mats in building entrances	*Costs*	Moderate (materials, personnel)
		Precedent	Offered at some military installations/ other government and non-government organizations)
		Benefits	Removal of hazard will reduce risk
		Disadvantages	Extra duty/ responsible party, mechanism, resource provision Other physical hazards to staff (lifting/shoveling, or skin contact with salt/melting compound

In deployed settings, the most common hazards attributed to walking and marching falls were outdoor surface irregularities (in 48% of these injuries). Inadequate lighting also contributed to a large portion of walking and marching falls (16%). Many of the deployed setting injuries are also presumed to involve Soldiers carrying loads, though this factor is likely underreported. Fatigue is another factor that may have been underreported.

A common fall injury included Soldiers walking on patrol at night with limited lighting, falling due to a surface irregularity or object (e.g., a hill, hole in the ground, rock, or branch). Some incidents described an individual carrying a load, while others did not. Based on prior documented evidence [55], this factor is likely to have been underreported for many deployed patrol marching or walking activities. Carrying heavy loads has been identified as a risk factor for back pain and related injury [56, 55]. However, the relationship of increased loads carried by Soldier in deployments to fall-related injuries has not been shown.

Interventions for reducing falls associated with a combination of factors including carrying loads while fatigued in night-time/low light conditions is not clear. Engineering and administrative controls may be evaluated to determine whether equipment loads and fatigue can be reduced, especially for night patrols. As it is not clear whether night-vision was used in all cases of limited lighting, the effectiveness of current engineering and implementation of such devices could not be determined.

Some intervention studies in elderly and injured persons undergoing rehabilitation have indicated the potential effectiveness of balance-related interventions to improve recovery reactions for falls (e.g., [57]). Theoretically, interventions to improve balance might help reduce the risk of fall injury to Soldiers exposed simultaneously to factors such as fatigue, rough terrain, poor lighting, and carrying heavy loads. However, neither the current literature nor the findings of this investigation provide enough evidence to support this hypothesis.

Coding “walking or marching” in addition to the fall code would capture the primary activity but would still not provide adequate information to reduce these fall-related injuries. A secondary hazard code is also needed to reflect the circumstances. Existing codes do not appear to capture factors such as carrying a load (e.g., while on patrol), fatigue, or low-lighting, which were all found to be key factors in deployed setting fall-related incidents. Example existing ICD-CM- 9 Activity codes that may be used to capture falls while walking or marching include:

E001.0=Walking/marching/hiking
E001.9=Snow/ice (other activity)

For scenarios involving contributing factors such as ice or carrying a heavy load, alternative or added codes may be useful:

E908.3= Blizzard (snow) (ice)
E927 = Overexertion/strenuous movement

7.4.4 Climbing

Though climbing-related fall incidents in the non-deployed settings were most commonly associated with stairs, no consistent problem associated with engineering controls such as stairs or handrails were noted (e.g., the design, structure, or absence of these controls). Therefore, no specific interventions can be recommended. Though ladders and scaffolds are often hazards in certain

industrial settings, these were not frequently noted in the Army narratives investigated. Potential existing ICD-9-CM codes that would address the types of scenarios identified include:

E880.1 = Fall from sidewalk curb
E880.9 = Fall from stairs or steps
E881.0 = Fall from ladder

Climbing-related incidents in the deployed settings were most commonly associated with non-moving transport vehicles. Falls involving these non-moving vehicles generally occurred while boarding or alighting and are addressed in Section 7.4.7. Several climbing-related falls in deployed settings were also related to surface irregularities.
An ICD-9-CM code to address falls due to surface irregularities include

E883.9 = Fall into hole cavity, etc.
E888 = Fall from slip/trip/stumble (This code is not recommended, as it is generic.)

Factors such as carrying loads, fatigue, and poor lighting are also likely (underreported) factors contributing to climbing-related fall injuries, as was previously discussed for the walking/marching activities in deployed settings. For scenarios involving contributing factors such as ice or carrying a heavy load, alternative or added codes may be useful:

E908.3= Blizzard (snow) (ice)
E927= Overexertion/strenuous movement

7.4.5 Occupational Tasks

Occupational tasks were not substantially associated with the non-deployed fall-related incidents. While occupational tasks made up over half of the deployed setting injuries, the activities were somewhat difficult to differentiate between climbing and walking/marching, as many occurred while on patrol or working on a vehicle. Similar to the falls during climbing activities, non-moving transport vehicles were the most frequent contributing factor to fall incidents during occupational tasks in deployed settings. A specific evaluation of the types of vehicles is addressed in Section 7.4.7. Similar to the walking/marching and climbing activities, it is assumed (though it was not often described explicitly in the narrative) that personnel were carrying loads during some of these incidents.

Interventions and cause codes previously discussed for walking or marching, climbing, and non-moving vehicles are also applicable to similar occupational task-related incidents.

7.4.6 Physical Training and Combat Training

Neither physical training nor combat training activities were attributed to many of the reported fall-related injuries (physical training accounted for 8% non-deployed and 5% deployed); combat training was associated with 7% of the non-deployed injuries and only one incident in deployed setting). Though surface irregularities were a common factor for physical training injuries, no pattern or controllable factor was noted. Of the combat training injuries, at least half were due to obstacle courses and included structures such as climbing walls, ropes, monkey bars, or ladders. Interventions could not be ascertained from the information available, as no specific engineering or procedural deficiencies were noted.

Example ICD-CM-9 activity codes that could be used to capture these types of incidents include:

E001.9 = Walking/Running (running);

Cardiorespiratory activities (E009.X):
E009.0 = Exercise machines
E009.2 = Calisthenics
E009.4 = Obstacle course

Muscle strengthening activities (E010.X):
E010.0 = Exercise machines
E010.1 = Sit ups/push-ups/pull-ups
E010.2 = Free weights

7.4.7 Motor-vehicles (non-moving, non-collision)

Non-moving motor vehicles were a leading hazard factor in both non-deployed and deployed fall injuries that occurred during climbing and occupational-related activities. These injuries primarily occurred while boarding or alighting a vehicle; others occurred during the conduct of a specific task like loading or unloading an object. This is consistent with the findings of a prior study [17]. Though the types of vehicles were not always specifically provided, information from the narratives provided enough details to categorize the types of vehicles. There were notable differences in types of vehicles non-deployed and deployed settings.

In non-deployed settings, light- to medium-wheeled vehicles (e.g., High Mobility Multipurpose Wheeled Vehicles (HMWWVs)), along with personally owned vehicles (POVs), were the type of vehicles most frequently involved in non-moving vehicle fall injuries. The vehicle type most frequently involved in the fall-related injuries in deployed settings was the MRAP vehicle. Though the production of MRAP vehicles had ended by CY 2011 (personal communications, August 27 2015; Alfred Rice, Deployments and Operations Working Group JS, J3, J35 Readiness Division), the use of these vehicles had steadily increased in the CENTCOM area of operation from the initial variants produced in 2007. By CY2011 25,000 MRAP had been produced and deployed. The MRAPs had increasingly replaced the use of other vehicles as such as the HMWWVs as a means to increase survivability. Previous evaluations of casualties associated with MRAPs identified rollovers as a primary cause of fatalities and injuries (from crushing and piercing, blunt trauma, and drowning including from being ejected). Next most common injuries reported have been cuts, pierces, crushing (especially of hands and fingers), due to door and handle design features. Several design improvements have reduced some of these injuries, though unique design feature of the different MRAP variants (i.e., different manufacturers) have not been fully evaluated. Though prior MRAP evaluations have included falls, they have not specifically evaluated the fall injuries from non-moving MRAPs as identified in this analysis. Prior recommendations (58) to reduce overall MRAP-related injuries have identified the need for improved training including use of simulators. Inadequate training and awareness MRAP design and use (all variants) may be a means to reduce fall-related injuries. Other contributing factors (e.g., carrying loads and fatigue) should be considered in future training and design improvement. Light- to medium-wheeled military vehicles still presented a non-moving vehicle fall-hazard in deployed settings. Possible reasons these were less frequently involved in the deployed fall-injuries than the MRAPs include: 1) HMMWVs sit over 2 feet lower than the MRAPs so present less of a climbing hazard; personnel exposure to MRAPs may have been greater given the maximum production and heightened reliance of these vehicles as personnel carriers by CY2011.

MRAP vehicles were not associated with any reported fall injuries in the non-deployed setting. This is presumed to be due to the limited MRAP availability and use (training) in garrison during this time (personal communications, August 27 2015; Alfred Rice, Deployments and Operations Working Group JS, J3, J35 Readiness Division). As noted, the lack of familiarity or training may have increased risk of falls when used in deployments.

Codes for describing these types of injuries should reflect the vehicle as the primary hazard factor. Existing ICD E-codes for transport vehicles could be used. Specifically:

E817.9 = Motor vehicles (boarding/alighting) (non-collision) (.9 Unspecified)

7.4.8 Other

Though far fewer in number, some incidents were not captured in the previously mentioned activity categories. These incidents are addressed by existing ICD-9-CM E codes for falls, but a previously discussed activity code could be used in place of these if appropriate.

E882 = Fall from building/structure
E884.4 = Fall from a bed
E884.5 = Fall from furniture
E885 = Falls that involved surfaces either (slip/tripping stumbling)
E888.8 = Accidental fall/from bumping into object/ non-specified fall on same surface

7.5 Limitations

This study is an investigational assessment of a single year of data; however, the results are comparable to prior analyses of Army non-deployed and deployed setting injury data. The inherent subjectivity and potential for bias involved in the review of narratives and creation of new coding variables was minimized by use of the 2-person systematic method. The collective data is expected to substantially underreport certain injuries (especially for non-traumatic and non-acute musculoskeletal injuries that resulted in outpatient and/or delayed medical treatment). Results are assumed to be skewed to reflect the most severe acute incidents, as these are more likely to have met safety reporting thresholds, received investigative attention, and thus been documented in the casualty and safety datasets. The injury rates in this evaluation were calculated for demographic groups in the non-deployed and deployed settings to assess potential intrinsic risk factors and differences based on deployment status. The external factors (activities and hazards) are presented only as frequencies since Army-wide population exposures to each activity or type of hazard were not available.

8 Conclusions and Recommendations

8.1 General

Rates for fall-related injuries among Active Duty Army populations during CY 2011 were not statistically different between non-deployed and deployed settings. Findings regarding these rates as well as basic demographics and types of injuries are generally comparable to those of prior studies. Though Soldiers under 30 years of age and of lower enlisted ranks (E1 to E4) were more frequently injured in fall-related incidents, no group stands out as having exceptionally high risk of injury. Less than 1 percent of the fall-related injuries in both non-deployed and deployed sessions were fatalities or (acute) permanently disabling injuries (such as amputations). The remaining injuries were identified as temporarily disabling. Of these, the most common type of injuries for both non-deployed and deployed settings were fractures followed by sprains and strains. Lower extremities are the most commonly injured body region in fall-related incidents.

Fractures are serious injuries that can result in an estimated 120 days of limited or lost duty per fracture injury. Sprains and strains, also results in substantial restriction and lost days (an estimated 90 days per injury). In some cases, these temporary injuries may result in long-term or even permanent disabilities that would not be captured in the incident reporting systems used in this analysis. In addition to extensive lost duty time, the medical costs of treatment for these injuries, which represent some of the most common reasons for Army hospitalizations and medical evacuations, are also not reflected by the narrative reports used in this analysis. The seriousness of these types of non-fatal injuries should be given greater emphasis in medical and accident/mishaps documentation.

8.2. Priority Fall-Related Injury Activities and Hazard Factors

The fall-related injury rates, basic demographics, and most common injury types identified for both non-deployed and deployed settings by this investigation are generally comparable to those of prior studies. However, this analysis suggests unique differences in activities and contributing hazards attributed to the injuries in each setting. This highlights the limitations of grouping “falls” into a single injury-cause category. In order to identify effective means to reduce the occurrence and severity of fall-related injuries, standardized codes for activities and contributing hazard factors are needed. While not all activities and hazards can feasibly be listed as pre-identified codes, the results of this investigation can be used to determine a prioritized list of associated activities and contributing hazard factors for non-deployed and deployed settings:

Non-deployed settings. Leading activities associated with fall-related injuries in non-deployed settings include sports (22%), parachuting (20%), walking or marching (19%), and climbing (15%). Snowboarding was identified as the most hazardous sport in non-deployed settings, followed by basketball. Ice and snow were primary hazards for walking and marching falls. Boarding and alighting from non-moving vehicles were common factors in climbing-related fall injuries. In non-deployed settings, the types of vehicles most commonly involved in these fall incidents were personally owned vehicles and light- to medium-wheeled military vehicles like HMMWVs.

Deployed settings. A majority (53%) of the fall injuries in deployed settings occurred while a Soldier was conducting an assigned occupational task. However, many of these occupational tasks included other activities, such as walking or marching (24%, e.g., on patrol), or climbing (23%, e.g., boarding or alighting from a non-moving vehicle). Sports were also attributed to a high number of

fall-related injuries (17%) in deployed settings. The leading sport associated with fall-related injuries in the deployed settings was basketball. Boarding and alighting from non-moving vehicles were primary factors in both climbing and occupational task-related fall injuries in deployed settings. The MRAP was the vehicle type most frequently involved in these vehicle fall incidents. Other notable contributing factors in deployed settings included inadequate lighting, carrying a load, and fatigue.

8.3 Fall-Related Injury Interventions

Though available intervention data for healthy adults in occupational settings is limited, some interventions applicable to the Active Duty Army population could reduce the number of fall-related injuries for certain activities and conditions. The following summarizes potentially modifiable fall-related activities and contributing hazard factors that were identified by this investigation.

- **Basketball**. Consistent with prior data, basketball was found to be a leading sport associated with fall-related injury in both non-deployed and deployed scenarios. These were primarily lower extremity injuries such as ankle sprains or fractures. As prior studies have also demonstrated an effective intervention for ankle injuries related to basketball (i.e., ankle braces), requirements regarding the use and/or educational information products regarding the benefits of ankle braces during basketball are recommended.

- **Parachuting.** This evaluation supports other studies that have identified injury types and risk factors associated with military parachuting. The prior studies have also evaluated and confirmed the effectiveness of outside-of-the boot ankle braces to reduce the frequency and severity of ankle-related injuries. As an effective intervention for this hazardous fall-related injury activity, a requirement for use of outside-of-the boot ankle braces during parachuting jumps is recommended.

- **Icy and snowy conditions.** Policy and doctrine on cold weather injuries including Technical Bulletin, Medical (TB MED) 508 should be updated to highlight ice and snow as major contributors to fall-related injuries. Since persons may be at greater risk in areas less prone to ice conditions due to a lack of anticipation of conditions and/or a lack of engineering controls in place, fall risks associated with ice and snow should be emphasized in all locations. Installations should enforce appropriate contracts, equipment, and procedures to remove and control ice and snow in a timely fashion. Though evidence is not currently available to quantify the benefits, multifaceted approaches utilizing low cost interventions such as increased local alerts, signage in areas of icy conditions, and reporting mechanisms for icy hazard areas should be considered by local entities.

- **Non-moving vehicles – boarding and alighting.** In non-deployed, fall-related injuries occurred most frequently from light to medium high mobility multi-purpose wheeled vehicles (i.e., HMMWVs) and personally operated vehicles (POVs). In deployed settings, fall-related injuries most frequently occurred from mine resistant armor protected (MRAP) vehicles. A lack of familiarity or training with the MRAP vehicles, along with contributing factors such as load carriage and fatigue, may play a role in deployed boarding and alighting fall-related injuries. Further assessment is recommended to identify whether interventions unique to vehicle types may be beneficial.

- **Walking/Marching and Climbing**. Potential interventions include engineering controls like improved night vision, mechanisms to reduce load carriage impact, balance controls,

balance training, and procedures to reduce fatigue. However, current data are not available to estimate any potential benefits or evaluate the effectiveness of such measures.

- **Physical Training and Combat Training**. Resulted in few of the fall-related injuries in this analysis; therefore no specific factors or interventions were identified.

8.4 Cause coding and future data capture

Databases that collect information about fall-related injuries do not always collect critical details about the activity and/or hazard factor(s) in a readily extractable and consistent form. Descriptions of locations (home, worksite, healthcare facility), activities (specific job tasks, sport or recreation, personal day-to-day tasks), or hazards (ice, stairs, slippery indoor surface) are either incompletely provided or inconsistently grouped. As a result, the types of interventions and their efficacies cannot be adequately investigated.

In the military, nationally accepted injury cause codes are not routinely or consistently documented in medical recordkeeping or safety and casualty reporting systems (e.g., ASMIS, TRAC2ES, and DCIPS). As falls has been identified as a leading cause of injuries, improved documentation of codes for primary activities and contributing factors in both medical and safety databases is needed in order to conduct surveillance efforts, track causal activities and hazards, and prioritize specific injury prevention efforts. Without more details about the activities and hazard factors, the Army cannot initiate programs to reduce fall-related injuries.

Gap and inconsistencies in reporting systems could be improved to facilitate the monitoring of fall-related injuries and priority activities and hazards. For example, nationally-recognized injury cause codes are not routinely documented in military medical record keeping or safety or casualty reporting systems. On the other hand, some data systems capture additional coded variables, but the codes are not well defined or consistently used. For example, some reporting systems already capture whether a fall was “from a height” versus “from surface” or “from stairs.” However, these variables were not consistently applied, and thus were problematic when trying to interpret. As a result, while falls from heights may be presumed to result in the more severe injuries, neither the current evaluation nor prior studies have shown this. This may be partially due to the noted gaps in accident reporting, which has historically captured only a small portion of the more severe medically treated injuries. In addition, more distinction between types of surfaces and heights, including the activity and/or object involved, is necessary to establish interventions and prevention strategies.

This study established several variables and a coding system to analyze narrative data, which were compared to existing ICD E-cause codes. The ICD-9-CM E-cause codes that would cover the majority of the primary activities and hazards identified in this investigation are suggested in **Appendix E.** Also included are comparable ICD-10-CM codes. (Beginning October 2015, DOD will be required to replace ICD-9-CM codes with ICD-10-CM codes.) Preference should be directed to attributing a fall-related injury to a specific activity code (e.g., basketball, boarding or alighting from a vehicle) in addition to the primary cause code. However, in circumstances where a specific hazard (e.g., ice or snow, overexertion) or object (a curb/sidewalk, a ladder, or a bed) are a primary contributing factors to the incident, the causal factor code may be more appropriate. In systems and scenarios that allow, multiple E-codes could be selected.

It is recognized that any requirement to use ICD E-codes could prove to be burdensome to those who input data in established medical and safety reporting systems. The shortened list of codes

suggested by this analysis (**Appendix E)** provides a possible means to prioritize ICD codes that may be most useful. Current medical and safety systems would still need to be changed to accommodate these recommendations. As this is a broad issue applicable to injuries of other mechanisms, pending changes should focus on accommodating the future ICD-10-CM codes (**Appendix E**) as opposed to ICD-9-CM codes in current use.

9 Point of Contact

The U.S. Army Public Health Command Injury Prevention Program is the point of contact for this project, e-mail usarmy.apg.medcom-phc.mbx.injuryprevention@mail.mil, or phone number 410-436-4655, DSN 584-4655. Specific questions may be directed to author(s) listed at the front of this report.

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Appendix A

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Appendix B

ICD-9-CM E-Codes
Potentially Associated with Unintentional Falls

Highlighted cells in following Tables are cause codes that could have been used to describe the various fall-related injuries identified in this assessment of CY2011 documented incidents.

(This assessment did not attempt to match up the identified incidents with medical records and cause codes)

Table B-1. ICD-9-CM E-Codes Potentially Associated with Unintentional Falls

Category	E-Code	4th digit as required/notes
CAUSE STATUS (E000-E000)		
Cause Status (Scenario)	**E000.X**	.0 Civilian activity for income or pay .1 Military activity .2 Volunteer activity .8 Other external cause status .9 Unspec external cause status
ACTIVITY CODES (E001-E030)		
Walking/Running	**E001.X**	.0 Walking marching/hiking .9 Running
Water/Watercraft	**E002.X**	.0 Swimming .1 Diving/platform .2 Water polo .3 Water aerobics/exercise .4 Underwater dive/snorkel .5 Row/canoe/kayak/raft/tube .6 Water skiing/wake boarding .7 Surf/windsurf/boogie board .8 Water sliding .9 Other involving water craft
Snow & Ice	**E003.X**	.0 Ice skating .1 Ice hockey .2 Hill skiing/boarding/sleds .3 Cross country skiing .9 Other involving ice/snow
Climbing/rappelling/jumping	**E004.X**	.0 - .9 (mountain climbing, rappelling, BASE jump, hang gliding)
Dancing/rhythmic moving	**E001.X**	.0 Dancing .1 Yoga .2 Gymnastics .3 Trampoline .4 Cheerleading .9 Other
Sports/athletics (individual)	**E001.X**	.0 Roller skating .1 Horseback .2 Golf .3 Bowling .4 Bike riding .5 Jump rope .6 Non-running track & field .9 Other
Sports/athletics (team)	**E007.X**	.0 American tackle football .1 American touch/flag football .2 Rugby .3 Baseball .4 Lacrosse & Field hockey .5 Soccer .6 Basketball .7 Volleyball .8Game(recess/camp/children) .9 Other
Other sports	**E008.X**	.0 Boxing .1 Wrestling .2 Racquet/hand sports .3 Frisbee .4 Martial arts .9 Other

Cardiorespiratory activity	**E009.X**	.0 Exercise machine (cardio) .1 Calisthenics .2 Aerobic/step .3 Circuit .4 Obstacle course .5 Grass drills .9 Other
Muscle strengthening	**E010.X**	.0 Exercise machine (strength) .1 Push up, pull up, sit ups .2 Free weights .3 Pilates .9 Other
Computer tech/electronics	**E011.X**	.0, .1, .9
Arts/handcrafts	**E012.X**	.0, .1, .2, .9
Hygiene/home maintenance	**E013.X**	.0 Bathing/showering .1 Laundry .2 Vacuuming .3 Ironing .4 Floor mopping/cleaning .5 Residential relocation .6 Other personal hygiene .9 Other
Care-giving	**E014.X**	.0, .1, .9
Food preparation/cooking	**E015.X**	.0, .1, .2, .9
Property/land maintenance/ building/construction	**E016.X**	.0 Digging/shoveling/raking .1 Gardening/landscaping .2 Building/construction .9 Other
Roller coaster/external move	**E017.X**	.0,.9
Musical instruments	**E018.X**	.0, .1, .2, .3
Animal care	**E019.X**	.0 Walking .2 Milking .3 Grooming/shearing .9 Other
Other activity	**E029.X**	.0 Refereeing .1 Spectator .2 Rough housing/horseplay .9 Other
Unspecified	**E030**	No other digit required
PLACE OF OCCURRENCE		
To denote place where injury/poisoning occurred	**E849.X**	.**0 Home** (private residence) .1 Farm .2 Mine/quarry .3 **Industrial place/ premises** *** construction, garage, warehouse** .4 Place for recreation/ sport .5 Street and highway .6 Public building/adjacent grounds *** office, bank, restaurant** .7 **Residential institution*** *** dormitory, hospital, jail, [barracks]** .8 Other specified places* *** forest, hill, beach, parking lot** .9 Unspecified place

Codes found at: http://www.icd9data.com/2015/Volume1/E000-E999/default.htm

Table B-2. Non-Traffic Vehicle ICD-9-CM E-Codes Potentially Associated with Falls

TRANSPORT VEHICLE- RELATED ACCIDENTS (E800-848)			
Category	**E-Code**	**Description**	**4th digit as required/notes**
Rail Accidents	**E804.**X	Boarding/alighting, fall out/in	.0 Employee .1 Passenger .2 Pedestrian .3 Pedal cyclist .4 Other/unauthorized .5 Unspecified
Motor Vehicle	**E817.X**	**Board/alight (non-collision)**	.0 Driver .1 Passenger .2 Motorcyclist .3 Motorcycle Passenger .4 Occupant of streetcar .5 Rider, animal/ drawn vehicle .6 Pedal cyclist .7 Pedestrian .8 Other .9 Unspecified
	E820.X	Snow vehicle (non-traffic)	
	E821.X	Off road vehicle (non-traffic)	
	E824.X	Other non-traffic while boarding/alighting	
Water transport	**E833.X**	Fall from stairs/ ladder, water transport	.0 Occupant unpowered small boat .1 Occupant powered small boat .2 Occupant other watercraft-crew .3 Occupant other watercraft- not crew .4 Water skier .5 Swimmer .7 Dockers, stevedores .8 Other .9 Unspecified
	E834.X	Other fall from one level to another in water transport	
	E835.X	Other and unspecified fall in water transport	
Air and space	**E843.X**	Boarding/alighting; Fall in, on, from	0 Occupant of spacecraft .**1 Occupant military aircraft*** * **excludes parachuting, police** .2-.4 Commercial aircraft crew/occupants .5-.6 Occupant – non commercial **.7 Parachutist military/other*** * voluntary descents only .8 Ground crew/airline employee .9 Other
Vehicle accident not elsewhere classifiable (NEC)	**E846**	Involving vehicles used solely on buildings/ premises of commercial industrial establishment	Not required
	E848	Involving other vehicles, NEC	

Table B-3. ICD-9-CM E-Codes for Accidental (Unintentional) Falls

ACCIDENTAL FALLS ***(Excludes: transport related incident E880- 899)***			
Category	**E-Code**	**Description**	**4th digit as required/notes**
Falls from Heights *(also see falls from one level to another 884.X)*	**E880.X**	From stairs or steps	.0 Escalator .1 sidewalk curb .9 Other stairs or steps
	E881.X	From ladders or scaffolding	.0 Ladder .1 Scaffolding
	E882	From or out of building/structure	No extra digit required. (Balcony. bridge, tower, window, roof, etc., Excludes burning structures)
Surface falls	**E883.X**	Fall into hole or open surface	.0 Water (excludes water downing) .1 Well .2 Storm drain or manhole .9 Other Hole, cavity, pit, quarry, shaft,
Falls one level to another *(also see falls from heights 880-882 above)*	**E884.X**	Falls one level to another	.0 Playground equipment .1 Cliff .2 Chair .9 Wheelchair .4 Bed .5 Furniture .6 Commode .9 Other* * embankment, stationary vehicle, tree
Fall on same level from slipping, tripping, stumbling *(also see falls from surface 883.X above)*	**E885**	Fall on same level from slipping, tripping, stumbling	No extra digit required.
Fall on same level from collision *(includes sports)*	**E886.X**	Involves collision with person/object	.0 sports .9 unspecified/non-sport
Fracture, cause unspecified	**E8887**	Fracture, cause unspecified	No extra digit required.
Other and unspecified fall	**E8888**	Accidental fall, NOS; from bumping object; on same level NOS	No extra digit required.
Late effects from accidental injury	**E929.X**	Late effects from accidental fall	**.3**

OTHER CAUSAL FACTORS			
Category	**E-Code**	**Description**	**4th digit as required/notes**
Accident due to natural or environmental factor	**E908.3**	**Blizzard (snow) (ice)**	
Overexertion and strenuous movements	**E927**	Excessive exercise/ strenuous move	overexertion from lifting, pulling, pushing; Could include loaded march

Appendix C

Selected STANAG Codes Relevant to Falls-Related Injuries

Highlighted cells in following Tables are cause codes that could have been used to describe the various fall-related injuries identified in this assessment of CY2011 documented incidents. Yellow highlighted cells appear most directly related to narratives reviewed, grey cells provide additional, though less directly linked criteria.

(This assessment did not attempt to match up the identified incidents with medical records and cause codes)

Table C-1. STANAG Air Transport (Non-Battle Accidents) Injury Cause Codes

Codes 000 – 059	
000	Boarding/alighting fixed-wing
004	Landing other/unspecified fixed-wing
005	Termination not at airfield fixed-wing
009	Other fixed-wing
010	Boarding/alighting rotary-wing
012	Taxiing other/unspecified rotary-wing
014	Landing rotary-wing
015	Termination of flight rotary-wing
016	Rotary-wing aircraft other
022	Parachute-Failed to open
024	Parachute-Initial impact with ground
025	Parachute-Being dragged by open parachute after landing
026	Parachute-Other or unspecified circumstances
028	Accident on aircraft
029	Accident was not specified occurring on aircraft carrier
030	Commercial fixed-wing/ unspecified wing
035	Other non-military aircraft (was boarding/alighting from)
038	Parachuting from nonmilitary aircraft due to non-aircraft damage
042	Spacecraft accident during ascent
049	Other/unspecified accident
052	Impact with aircraft/spacecraft parts

Table C-2. STANAG Land Transport (Non-Battle Accidents) Injury Cause Codes

Codes 100 – 149	
100	Non-mil:Injury is to driver of motor vehicle
101	Non-mil:Injury is to passenger of motor vehicle
102	Non-mil:Injury is to unspecified occupant of motor vehicle
103	Non-mil:Boarding/alighting from vehicle
104	Non-mil:Injury is to pedestrian
105	Non-mil:Injury is to pedal cyclist
106	Non-mil:Injury is to motocyclist
107	Non-mil:Driver/rider on tracked or semitracked vehicle
109	Non-mil:Injury is to other or unspecified person
110	Mil Veh:Injury is to driver of motor vehicle
111	Mil Veh:Injury is to passenger of motor vehicle
112	Mil Veh:Injury is to unspecified occupant of motor vehicle
113	Mil Veh:Boarding/alighting from mil vehicle
114	Mil Veh:Injury is to pedestrian
115	Mil Veh:Driver/rider on mil pedal cycle
116	Mil Veh:Driver/rider on mil motorcycle
117	Mil Veh:Injury is to occupant of tracked or semitracked
119	Mil Veh:Injury is to other unspecified person
120	Nontraffic,driver of nonmil veh
121	Nontraffic,rider of nonmil veh
122	Nontraffic,unspecified occcup of nonmil veh
123	Nontraffic,boarding/alighting from nonmil veh
124	Nontraffic, ped by nonmil veh
126	Nontraffic, motorcycle driver/rider by nonmil veh
127	Nontraffic,occup of nonmil tracked/semitracked veh
129	Nontraffic,other/unspecified person by nonmil veh
130	Injury (nontraffic) to driver of mil veh
131	Nontraffic,passenger mil veh
132	Nontraffic,unspecified occcup of mil veh
133	Nontraffic,boarding/alighting mil veh
134	Nontraffic,ped by mil veh
136	Nontraffic,motorcycle driver/rider by mil veh
137	Injury (nontraffic) to occupant of mil tracked/semitrac
139	Nontraffic,other/unspecified person by mil veh
140	Railway
149	Other specified land transport accident

Table C-3. STANAG Water Transport (Non-Battle Accidents) Injury Cause Codes

Codes 150 – 199	
151	Submersion,occup small boat
159	Submersion,other
160	Water,fall boarding/alighting
161	Water,boarding/alighting
162	Water,different level fall
163	Water,same level fall
164	Water,twisting/turning/slipping/running
172	Water,other machinery
190	Water,other/boarding/alighting
194	Rough weather effects
195	Diving accidents non-drowning/air deficiencies code
196	Watertight doors/hatch covers
199	Nautical others

Table C-4. STANAG Athletics and Sports (Non-Battle Accidents) Injury Cause Codes

Codes 200 – 249	
201	On ship basketball
203	On ship boxing
204	On ship PT
212	On ship softball, rounders
213	On ship swimming and diving
216	On ship wrestling,judo
219	On ship -Other athletics & sports
220	Baseball
221	Basketball
222	Boating
223	Boxing
224	PT - calistenics/gymnastics
226	Football
227	Handball, squash, jai alai
228	Hockey
229	Mountaineering,tobogganing
230	Rugger
231	Soccer, football
232	Softball & rounders
233	Swimming,diving,waterpolo
234	Tennis,badminton
235	Track & field
236	Wrestling, judo
237	Horsemanship
239	Other athletics & sports

Table C-5. STANAG Machinery and Tools (Non-Battle Accidents) Injury Cause Codes

Codes 600 – 699	
600	Machinery in air
601	Machinery at sea
602	Machinery airfield
607	Machinery kitchen
608	Machinery residence
609	Machinery land,NEC
611	Tools at sea
614	Tools industrial plant
618	Tools residence
619	Tools land,NEC
622	Electric current airfield
624	Electric current industrial plant
628	Electric current residence
629	Electric current land,NEC
639	X-ray/radiaton land,NEC
641	Cutting/piercing instrument at sea
644	Cutting/piercing instrument industrial plant
645	Cutting/piercing instrument range
647	Cutting/piercing instrument kitchen
648	Cutting/piercing instrument residence
649	Cutting/piercing instrument land,NEC
651	Pressure explosion,no fire at sea
659	Pressure explosion,no fire land,NEC
661	Falling object/missile at sea
664	Falling object/missile industrial plant
665	Falling object/missile range
666	Falling object/missile obstacle
667	Falling object/missile kitchen
668	Falling object/missile residence
669	Falling object/missile land,NEC
670	Static objects in air
675	Static objects range
676	Static objects obstacle
678	Static objects residence
679	Static objects land,NEC
685	Foreign object in body range
687	Foreign object in body kitchen
688	Foreign object in body residence
689	Foreign object in body land,NEC

Table C-6. STANAG "Falls and Misc" Injury Codes (Non-Battle Accidents)

900 – 999 Falls and Miscellaneous STANAG Injury Cause Codes

901	Fall stairs/ladders at sea	**Stair/ladder falls**
904	Fall stairs/ladders industrial plant	
905	Fall stairs/ladders range	
906	Fall stairs/ladders obstacle	
907	Fall stairs/ladders kitchen	
908	Fall stairs/ladders residence	
909	Fall stairs/ladders land,NEC	
910	Different level fall/jump in air	**Different level falls**
912	Different level fall/jump airfield	
914	Different level fall/jump industrial plant	
915	Different level fall/jump range	
916	Different level fall/jump obstacle	
918	Different level fall/jump residence	
919	Different level fall/jump land,NEC	
920	Same level fall/jump in air	**Same level falls**
921	Same level fall/jump at sea	
922	Same level fall/jump airfield	
923	Same level fall/jump dock	
925	Same level fall/jump range	
926	Same level fall/jump obstacle	
927	Same level fall/jump kitchen	
928	Same level fall/jump residence	
929	Same level fall/jump land,NEC	
935	Marching/drilling range	
936	Marching/drilling obstacle	
938	Marching/drilling residence	
939	Marching/drilling land,NEC	
942	Twisting/turning/slipping airfield	**“Near falls”**
945	Twisting/turning/slipping range	
946	Twisting/turning/slipping obstacle	
947	Twisting/turning/slipping kitchen	
948	Twisting/turning/slipping residence	
949	Twisting/turning/slipping land,NEC	
950-959	Lifting/pushing/pulling (air; sea; industrial plant; residence NEC)	**Not Fall related**
961-969	Strangulation (at sea; residence; land,NEC)	
973-979	Fighting (dock; range; obstacle; kitchen; residence; land,NEC)	
981-989	Other (at sea; range; obstacle; residence; land,NEC)	
990-999	Unknown (in air; industrial plant; range; obstacle; residence; land, NEC)	

Appendix D

Falls-Related Injury Frequencies and Rates

Table D-1. Frequency and Rate Calculations for Non-Deployed

	Non-Deployed Falls		Total Non-Deployed Army		Non-Deployed Person-Years [a]	
	N	%	N	%	all Army person-years	Non-Deployed person-years
Age						
<20	68	7%	26,041	6	28342	**26041**
20-24	347	35%	129,808	29	166362	**129808**
25-29	224	23%	113,886	25	143720	**113886**
30-34	121	12%	73,030	16	90945	**73030**
35-39	84	9%	54,443	12	66623	**54443**
>=40	88	9%	51,923	12	67862	**51923**
Unknown	56	6%	2	0	2	**2**
Total	988	100%	449,132	100	563856	**449132**
Gender						
Male	840	85%	384,852	86	487599	**384852**
Female	145	15%	64,280	14	76257	**64280**
Total	985	100%	449,132	100	563856	**449132**
Rank						
E1-E4	565	57%	205,428	46	261602	**205428**
E5-E9	294	30%	165,440	37	205316	**165440**
O1-O3, W1-W3	98	10%	48,875	11	61577	**48875**
O4-O9, W4-W5)			29,386	7	35359	**29386**
Unknown	31	3%	2	0	2	**2**
Total	988	100%	449,132	100	563856 [a]	**449132**

[a] DATA SOURCE: Defense Manpower Data Center (DMDC), accessed 3/30/2015 – 4/10/15 https://dmdc.osd.mil/appj/dwp/index.jsp

Table D-2. Frequency Calculations for Deployed

	Deployed Falls		Total Deployed Army		Deployed Person-years	
	N	%	N	%	person-days	person-years
Age						
<20	9	4%	3,366	2	840583	**2301**
20-24	78	31%	52,392	30	13351065	**36554**
25-29	75	30%	43,875	26	10896589	**29834**
30-34	21	8%	27,063	16	6543304	**17915**
35-39	24	9%	18,924	11	4448778	**12180**
>=40	17	7%	26,270	15	5821782	**15939**
Unknown	30	12%	1	0	90	**0**
Total	254	100%	171,891	100	41902191	**114724**
Gender						
Male	228	90%	154,389	90	37527641	**102747**
Female	25	10%	17,502	10	4374550	**11977**
Total	253	1	171,891	100	41902191	**114724**
Rank						
E1-E4	151	59%	80,286	47	20517011	**56174**
E5-E9	74	29%	61,001	35	14564445	**39876**
O1-O3; W1-W3	16	6%	19,289	11	4639313	**12702**
O4-O10; W4-W5			11,315	7	2181422	**5973**
Unknown	13	5%	0	0	0	**0**
Total	254	100%	171,891	100	41902191	**114724**

	Non-Deployed Falls		Deployed Falls	
	N	**Rate**	N	**Rate**
Age				
<20	68	2.61	9	3.91
20-24	347	2.67	78	2.13
25-29	224	1.97	75	2.51
30-34	121	1.66	21	1.17
35-39	84	1.54	24	1.97
>=40	88	1.69	17	1.07
Unknown	56		30	
Total	988	2.20	254	2.21
Gender				
Male	840	2.18	228	2.22
Female	145	2.26	25	2.09
Total	985	2.19	253	2.21
Rank				
E1-E4	565	2.75	151	2.69
E5-E9	294	1.78	74	1.86
O1-O3; W1-W3	98	2.01	16	1.26
O4-O9; W4-W5				
Unknown	31		13	
Total	988	2.20	254	2.21

Appendix E

ICD-10-CM Crosswalk

Table E-1. Key ICD-9-CM External Cause Codes for Fall Incidents Analyzed

Category	E-Code	4th digit as required	
CAUSE STATUS			
Cause Status (Scenario)	**E000.X**	**.0 Civilian activity** **.1 Military activity**	(.1) military training/job task/deployment
PLACE OF OCCURRENCE			
To denote place where injury occurred	**E849.X**	.0 Home {and premises} .3 Industrial {job} premises .4 Place of recreation/sports .7 Residential institution 0.8 other	.0 single residence .3 motopool, office, etc .4 gym, field, track, court .7 barracks/hospital
VEHICLE- RELATED ACCIDENTS			
Motor Vehicle	**E817.9**	**Board/alight** (non-collision)	
Air and space	**E843.7**	**Parachutist military/other*** * voluntary descents only	For all parachuting /airborne falls
ACTIVITY-BASED CODES (Selected codes are based on narratives from this analysis and potential interventions)			
Walking/Running	E001.X	.0 Walking marching/hiking .1 Running	
Snow & Ice	E003.X	.2 Hill skiing/boarding/sleds .9 Other involving ice/snow	E003.9 if during specific outdoor walking/hiking, otherwise E908.3
Sports/athletics (individual)	E006.X	.4 Bike riding .9 Other	
Sports/athletics (team)	E007.X	.0 American tackle football .1 Touch/flag football .5 Soccer .6 Basketball .7 Volleyball .9 Other	If fall occurred during sport – use sport code
Cardiorespiratory activity	E009.X	.0 Exercise machine (cardio) .2 Calistenthics .4 Obstacle course .9 Other	
Muscle strengthening	E010.X	.1 Push up, pull up, sit ups	E.g., falls from Pull up bars
Hygiene/home maintenance	E013.X	.0 Bathing/showering	Slipping on wet bathroom surface
Property/land maintenance/ building/construction	E016.X	.2 Building/construction	
FALLS FROM, OVER, INTO SPECIFIC OBJECTS (Select codes based on analysis and potential interventions)			
Outdoor curb/sidewalk	E880.1		Man-made surfaces
Stairs, Step	E880.2		
Ladder	E881.0		
Into hole/w/cavity	E883.9		Surface irregularity: Activity code should have precedence
Building/structure	E882		
From bed	E884.4		E.g., beds/bunks in barracks
Other furniture	E884.5		
ADDITIONAL CAUSAL FACTORS			
Accident due to natural or environmental factor	**E908.3**	**Blizzard (snow) (ice)**	
Overexertion and strenuous movements	**E927**	Excessive exercise/ strenuous movement	overexertion from lifting, pulling, pushing; Could include loaded march

Note: Existing codes do not appear to adequately capture factors such as carrying a load (such as while on patrol), fatigue or, or low-lighting which appear to be key factors noted in military deployed setting incidents.

Table E-2. Key ICD-10-CM (2015 Version) Recommended Codes

Category	E-Code	3rd and 4th digits, required	
CAUSE STATUS			
Cause Status (Scenario)	**Y99.X**	**.0 Civilian activity** **.1 Military activity**	(.1) military training/job task/deployment
PLACE OF OCCURRENCE			
To denote place where injury occurred	**Y92.XXX**	.09 Non-residential institution {home} **.13 Military base** - .133 Military base barracks .19 Residential institution **.48 Other paved roadways** - .480 Sidewalk - .481 Parking lot - .482 Bike path .6 Industrial {job} premises **.81 Transport vehicle** -.810 Car -.812 Truck .83 Place of recreation/sports .89 Other	
VEHICLE- RELATED ACCIDENTS			
Motor Vehicle	**V87.8XXA**	**Other specified non-collision involving motor vehicle**	Less specific than ICD-9, doesn't specify boarding/alighting
Air and space (Parachuting)	**V97.XXXX**	.21XA Entangled in object **.22XA Injured on landing**	For all parachuting /airborne falls
ACTIVITY-BASED CODES (Selected codes are based on narratives from this analysis and potential interventions)			
Walking/Running	Y93.XX	.01 Walking marching/hiking .02 Running	
Snow & Ice	Y93.XX	.23 Hill skiing/boarding/sleds .29 Other involving ice/snow	
Sports/athletics (individual)	Y93.XX	.55 Bike riding .59 Other	
Sports/athletics (team)	Y93.XX	.61 American tackle football .62 Touch/flag football .66 Soccer .67 Basketball .68 Volleyball .69 Other	**If fall occurred during sport – use sport code**
Cardiorespiratory activity	Y93.XX	.A1 Exercise machine (cardio) .A3 Calistenthics .A5 Obstacle course .A9 Other	
Muscle strengthening	Y93.XX	.B2 Push up, pull up, sit ups	E.g., falls from Pull up bars
Hygiene/home maintenance	Y93.XX	.E1 Bathing/showering	Slipping on wet bathroom surface
Property/land maintenance/ building/construction	Y93.XX	.H3 Building/construction	
FALLS FROM, OVER, INTO SPECIFIC OBJECTS (Select codes based on analysis and potential interventions)			
Outdoor curb/sidewalk	W10.XXXX	.1XXA	Man-made surfaces
Stairs, Step	W10.XXXX	.8XXA	
Ladder	W11.XXXX	.XXXA	
Into hole/w/cavity	W17.XXXX	.2XXA	Surface irregularity: Activity code should have precedence
Building/structure	W13.XXXX	.9XXA	
From bed	W06.XXXX	.XXXA	E.g., beds/bunks in barracks

Other furniture	W08.XXXX	.XXXA	
ADDITIONAL CAUSAL FACTORS			
Fall due to ice and snow	**W00.XXXX**	.0XXA Same level .1XXA Stairs/steps .2XXA To different level	**New for ICD-10**
Overexertion and strenuous movements	**X50.XX**	Excessive exercise/ strenuous movement	overexertion from lifting, pulling, pushing; Could include loaded march

Converted to ICD10 from ICD9 using:

www.icd10data.com

www.icd10codesearch.com

www.aapc.com/icd-10/codes

(http://apps.who.int/classifications/icd10/browse/2015/en)